Volume 23, Number 14 July 31, 1969

NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 26661, 27066, and 27112.

26148 (AERE-BIB-162) LIST OF UNCLASSIFIED DOCUMENTS, LECTURES, ETC., BY THE STAFF OF THE ANALYTICAL SCIENCES DIVISION, A.E.R.E., HARWELL. Leatham, J. M. (comp.) (Atomic Energy Research Establishment, Harwell (England)). Jan. 1969. 13p. Dep. CFSTI. UK 2s. 6d.

A list of 79 reports, memoranda, conference papers, books, lectures and journal papers is given. (UK)

26149 NONRADIOACTIVE PHYSICAL METHODS OF ANALYSIS DURING GASEOUS REPROCESSING OF NUCLEAR FUEL. Goossens, W. (Studiecentrum voor Kernenergie, Mol, Belg.). Ind. Chim. Belge, 33: 649-54(1968).

The nonradioactive physical methods of analysis applicable to the corrosive gas mixture involved in gaseous reprocessing of nuclear fuels are discussed and some experimental results are mentioned. A batch-type flow diagram corresponds to the most studied flow scheme by which U and Pu should be separately volatilized. The principal reaction steps are consecutively: a chemical decladding step, a U volatilization reaction, and a Pu volatilization step. During the chemical decladding step a mixture of gaseous HF and O_2 at 550°C reacts with the stainless steel can of the nuclear fuel in a fluidized bed of granular Al_2O_3. Volatilization of U is performed at temperatures below 300°C with ClF_3. Plutonium is then volatilized by using F_2 at 450 to 550°C. The following mixtures must be analyzed: (1) during chemical decladding: HF, O_2, H_2O, and gaseous fission products (Kr, Xe, I_2); (2) during U volatilization: UF_6, Cl_2, ClF, ClF_3, ClO_2F, F_2, N_2, O_2, HF, Cl_2O, ClO_2, volatile fluorides and oxyfluorides of Cr, Ni, and Fe, volatile fluorides of fission and decay products (NpF_6, MoF_6, TeF_6, IF_5, NbF_5, RuF_5; and (3) during Pu volatilization: PuF_6, UF_6, F_2, HF, fluorides and oxyfluorides of Cr, Ni, and Fe, and volatile fluorides of fission and radioactive decay products. Continuous monitoring analysis may be achieved by ir absorption spectrometry, uv absorption spectrometry, thermal conductivity cells, and sonic gas analyzers. Discontinuous monitoring analysis may be performed with mass spectrometry, microsublimation, and gas chromatography. Infrared spectrometry has promise for routine use as a continuous monitoring method and gas-liquid chromatography as a discontinuous one. (BBB)

26150 RAPID SPECTROFLUOROMETRIC DETERMINATION OF CERIUM IN HIGH-PURITY RARE EARTH OXIDES. Furukawa, Masamichi; Sasaki, Shozo (Government Industrial Research Inst., Nagoya, Japan). Nagoya Kogyo Gijutsu Shikensho Hokoku, 17: 251-6(Nov. 1968). (In Japanese).

Cerium(III) ions in dilute HCl exhibit a characteristic fluorescence with an excitation maximum at 257.5 mμ and a fluoroscence emission maximum at 350 mμ, which are applicable to the spectrofluorometric determination of cerium from 10^{-1} to 10^{-5}%. A large amount of La, Y, and Eu did not interfere. Praseodymium, Nd, Sm, Gd, Dy, Ho, and Yt (0.6 mg/ml), Lu and Tb (0.1 mg/ml), Tm (0.05 mg/ml), Sc (0.005 mg/ml), Co(II), Mn, Ca, and Mg (1 mg/ml), Ni and Pb (0.1 mg/ml), Cu, Fe(III), and Cr (0.01 mg/ml), V (0.002 mg/ml), and Hf (0.05 mg/ml) also did not interfere. The interference from a large amount of Fe(III) was eliminated by masking with hydroxylamine hydrochloride and this reducing agent was also most suitable for the reduction of Ce(IV) to Ce(III). The method was applied for the determination of Ce in a high-purity La, Y, and Eu oxide (99.9 to 99.99%). (NSA of Japan)

26151 SPECTROPHOTOMETRIC DETERMINATION OF COPPER IN PLUTONIUM METAL WITH 2,9-DIMETHYL-1,10-PHENANTHROLINE. Lindsay, J. W,; Plock, C. E. (Dow Chemical Co., Golden, Colo.). Contract AT(29-1)-1106. Talanta, 16: 414-16(Mar. 1969).

In the method described the copper is complexed with neocuproine, extracted into chloroform, and the absorbance read at 457 mμ. The average relative error of the methods is −1.4% with an average relative standard deviation of 4%. (auth)(UK)

26152 DETERMINATION OF STRONTIUM IN HUMAN BONE TISSUE. Golutvina, M. M.; Kuznetsov, A. A.; Novikova, N. Ya.; Nikolaev, Yu. M. Lab. Delo, No. 11, 669-70(1967). (In Russian).

Strontium is determined by flame photometry at 460 to 7 nm after complete removal of PO_4^{3-} from the sample. Bone is calcined in a muffle-furnace with periodic additions of concentrated HNO_3. The residue (1 g) is dissolved in HCl and the solution is adjusted to pH 1 with aqueous NH_3. An ammonium oxalate solution is added to the hot solution to precipitate the Ca and Sr oxalates, which are then separated by centrifugation. The precipitate is washed with aqueous ammonium oxalate, then dissolved in concentrated HNO_3, and the solution is diluted to a given volume with H_2O. Strontium is determined in this solution (in the presence of Ca) by the method of additions. The intensity is directly proportional to concentration for 0.2 to 50 μg of Sr per ml. The mean square error is 20%. (Anal. Abstr.)

26153 THIN-LAYER CHROMATOGRAPHY OF LESS-COMMON ELEMENTS. II. SEPARATION AND IDENTIFICATION OF RHENIUM(VII), MOLYBDENUM(VI), VANADIUM(V), AND TUNGSTEN(VI) IN HYDROCHLORIC ACID–ALCOHOL MEDIA. Gaibakyan, D. S.; Aturyan, M. M. (Erevan State Univ.). Arm. Khim. Zh., 20: 806-11(1967). (In Russian).

The behavior of these species was studied by ascending-solvent TLC on a 0.5-mm layer of aluminum oxide (without binder) by development with various mixtures of HCl with methanol, ethanol, propanol, or isopropyl alcohol. The maximum R_F values were obtained at a ratio of alcohol to acid of 1 : 3. Of various locating reagents tested, the best was found to be 20% $SnCl_2$ solution in HCl followed by 10% aqueous $K_3Fe(CN)_6$. The differences between the R_F values of the various pairs of elements for different solvent compositions are tabulated. The best solvent for separating Re from Mo and V is a 1 : 9 mixture of concentrated HCl with ethanol, propanol, or isopropyl alcohol. Molybdenum could not be separated from V in this type of system. (Anal. Abstr.)

26154 MICROCHEMICAL ANALYSIS OF TANTALONIOBATES. Fer'yanchich, F. A. Tr. Tsent. Nauch.-Issled. Gornorazved. Inst., No. 77, 227-38(1967). (In Russian).

Standard methods are described for determining Nb_2O_5, Ta_2O_5, SiO_2, Bi_2O_3, PbO, CaO, MgO, TiO_2, oxides of the rare earth metals, total Fe, FeO, ZrO_2 plus HfO_2, Al_2O_3, UO_3, MnO, SnO, CuO, F, alkali metals, SrO, BaO and H_2O; B_2O_3, S, CO_2 and P_2O_5 can also be determined. (Referativnyi Zh.)

Chemical Procedures

Refer also to abstracts 26326, 26538, and 28646.

26155 (AERE-R-5999) GRAVIMETRIC PROCEDURE FOR THE QUANTITATIVE DETERMINATION OF ZIRCONIUM AND OF NIOBIUM AS PHOSPHATE. Wallace, C. G. (Atomic Energy Research Establishment, Harwell (England)). Mar. 1969. 15p. Dep. CFSTI. UK 2s. 6d.

The recommended procedure involves evaporation of fluoride solutions of niobium or zirconium with nitric acid and a controlled excess of phosphoric acid. The phosphate precipitates produced after dilution are not hydrolyzed in aqueous ammonium nitrate or in dilute nitric acid solution. After ignition at 1100°C zirconium is quantitatively determined as the pyrophosphate, ZrP_2O_7, and niobium as the niobyl phosphate, $NbOPO_4$. Application to the analysis of zirconium–uranium mixtures showed that the separation of zirconium, from as much as ten times its weight of uranium, is quantitative in a single precipitation. The determination of niobium in the presence of uranium has a positive bias of approximately 2% after a single precipitation and slightly less than 1% after a double precipitation. (auth) (UK)

26156 (ARH–1079) THE USE OF AgCl–LiF AS A CARRIER IN THE SPECTROGRAPHIC ANALYSIS OF PLUTONIUM FOR COBALT. Akers, W. L. (Atlantic Richfield Hanford Co., Richland, Wash.). Mar. 1969. 7p. Dep. CFSTI.

Studies were made using various materials to determine their usefulness as spectrographic carriers or carrier-buffers in the determination of cobalt in plutonium dioxide prepared from plutonium metal. Silver chloride–lithium fluoride proved superior to gallium oxide and sodium fluoride for this purpose. (auth)

26157 (CEA-R–3369) HEAVY ELEMENT CONCENTRATION DETERMINATION BY THE X-RAY FLUORESCENCE ANALYSIS USING RADIOISOTOPE GAMMA-RAY SOURCES. Enomoto, Shigemasa (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). July 1968. 70p. (In French). Dep.

A theoretical and experimental study was made on the fluorescence analysis of high-atomic-number elements using γ-ray sources for excitation and characteristic K x rays for the measurement. The choice of the proper γ-ray energy according to the conditions of the determination is considered. The usefulness of using the backscattered γ-rays as a correction mean for matrix and grain-size effects was studied. Sources of ^{153}Gd, ^{57}Co, ^{137}Cs were used for excitation using collimated geometries. Concentration measurements of tungsten in steel, tungsten and lead in aqueous solution, PbS in SiO_2–PbS powder mixtures were done, as well as thickness evaluation of gold layers on copper. A precision of about 0.2% (abs.) is obtained for lead determination in light matrixes. A probe design is proposed for the continuous determination of lead in aqueous solutions. (auth)

26158 (CEA-R–3760) DETERMINATION OF IRON, NICKEL, AND CHROMIUM IN THE MASURCA SIMULATION RODS. Brigaudeau, Michele; Pierdet, Simone (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Mar. 1969. 47p. (In French). Dep.

A method was developed for determining the iron, nickel, and chromium content of sintered ternary oxide rods designed to simulate structural elements in the reactor MASURCA. A calculation was made of the conditional constant of the Fe–EDTA complex in a formic buffer solution, and of that of the Ni–EDTA complex in an ammoniacal buffer. From these two values it appears that it is not possible to carry out the iron and nickel determinations with a standard EDTA solution when these two elements are present simultaneously. That is the reason for which, in this case, a separation of the Fe and Ni is carried out in 8 N HCl solution on an anion exchange resin. Each element is then dosed by titricolorimetry. Chromium is determined by the same technique without prior separation. The reproducibility of the method was calculated for each of the three elements. The relative accuracy is: 0.58% for the iron; 1.41% for the nickel; and 0.39% for the chromium. (auth)

25159 (IFA-IS–55) ISOTOPIC ANALYSIS BY OPTICAL SPECTROSCOPY. Ungureanu, C.; Siara, I. (Academia R. P. R., Bucharest. Institutul de Fizica Atomica). 1969. 15p. Dep.

Spectroscopic methods are being developed for quantitative analysis of the isotopic composition of hydrogen and oxygen. Equipment with high-frequency excitation (150 MHz – 500W) and a Fabry–Perot spectrometer with photoelectric recording were employed. The isotopic structure was resolved by a Fabry–Perot interferometer scanned by magnetorestriction. (M.C.G.)

26160 (UCRL–50590) AUTOMATED PROCEDURE FOR COLORIMETRICALLY DETERMINING Au(III) IN SOLUTION. Rigdon, Lester P. (California Univ., Livermore. Lawrence Radiation Lab.). Mar. 26, 1968. 9p. Dep. CFSTI.

An automated method for extracting and spectrophotometrically determining Au(III) in solution was developed. The method is based on forming an $AuBr_4^-$/trioctylphosphine oxide complex, extracting the complex into chloroform, and measuring its absorption at 395 mμ in a dynamic system. Solutions containing 5 to 50 μg of Au(III) per milliliter can be analyzed with an accuracy of 5% or better. The method is applicable to mineralogical leaching solutions containing strong oxidants, Fe(III), and appreciable quantities of diverse anions and cations. Ethanolamine and possibly other amines seriously interfere by complexing Au(III) at a pH of 2 or more. Coulometric and spectral studies indicate a strong complex between Au(III) and ethanolamine. (auth)

26161 (VNIIRT–1) ROENTGENORADIOMETRIC EQUIPMENT AND METHODS OF RAPID-ANALYSIS FOR COPPER, IRON, AND OTHER ELEMENTS. Mamikonyan, S. V.; Kozlov, O. V.; Martishchenko, L. G. (Vsesoyuznyi Nauchno-Issledovatel'skii Institut Radiatsionnoi Tekhniki, Moscow (USSR)). 1968. 12p. (In Russian). Dep.

X-ray fluorescence determination of low concentrations of iron in oil and analyses of powdered copper ore concentrates using a bremsstrahlung ^{3}H/Zr source are described. Proportional counters and x-ray sources were used for measuring the wear of aviation, marine, and automobile engines. Sensitivities of the method for copper and iron are given. (R.V.J.)

26162 MASS SPECTROGRAPHIC DETERMINATIONS OF LANTHANIDE ELEMENT CONTENTS IN BASALTS. Graham, A. L.; Nicholls, G. D. (Univ. of Manchester, Eng.). Geochim. Cosmochim. Acta, 33: 555-68(May 1969).

It was found that lanthanide element population patterns in deep sea basalts vary with the degree of silica saturation of the rocks. In the olivine tholeiite series the more undersaturated examples show preferential enrichment of the lighter lanthanides. This relationship is not displayed by the high alumina olivine tholeiite. (auth) (UK)

26163 X-RAY FLUORESCENCE SPECTROGRAPHY: USE IN FIELD ARCHEOLOGY. Frierman, J. D. (Univ. of California, Los Angeles); Bowman, Harry R.; Perlman, I.; York, Carl M. Science, 164: 588(May 2, 1969).

A portable x-ray emission spectroscopy system was prepared and its feasibility for site analysis was tested. More than 300 separate analyses were obtained, often testing for 6 elements in a single 4-minute run. The operating environments were of all sorts—from hot, dry deserts to the seacoast with its attendant high temperatures and salty humidity. This method of field survey was found to be applicable to metals, glasses, glazed ceramics, and mineral specimens. Under field conditions, accuracies of 10 to 20% are obtainable when elements are present in the range of 0.1 to 30%. The sensitivity of analysis varies with the atomic number. (P.C.H.)

26164 SELECTIVE SPECTROPHOTOMETRIC DETERMINATION OF URANIUM. Keil, R. (Eidgenoessiche Institut fuer Reaktorforschung, Wuerenlingen, Switzerland). Z. Anal. Chem., 244: 165-9(1969). (In German).

A simple, versatile spectrophotometric uranium determination was developed, which is not disturbed by over 60 cations and about 20 anions investigated. A separation with triphenylarsine oxide is first performed. The uranium extracted is then transferred by a simple method to the 8-hydroxyquinoline-complex and measured spectrophotometrically. Larger quantities of uranium can be directly measured in the extract. Further experiments with other reagents as a substitute for 8-hydroxyquinoline are described. (auth)

26165 GONADOTROPIN LEVELS IN PUBERTY. I. SERUM LUTEINIZING HORMONE. Yen, S. S. C.; Vicic, W. J.; Kearchner, D. V. (Case Western Reserve Univ., Cleveland). J. Clin. Endocrinol. Metab., 29: 382-5(Mar. 1969).

Serum luteinizing hormone (LH) concentrations were determined by a specific radioimmunoassay in 175 boys and girls from 8 through 15 yr of age. The data show that serum LH was detectable at 8 yr for both boys and girls and that there was a progressive rise in serum LH concentrations as sexual maturity was reached. However, there appears to be a quantitative and qualitative difference in the LH increments between boys and girls: consistently higher serum LH concentrations were observed in girls than in boys. There was a 9-fold increase in the mean serum LH concentration in pubescent girls and only a 3-fold increase in pubescent boys. By age 14, the mean serum LH concentration in girls was reaching the adult female levels, but there was only 30% of adult male levels in boys. In addition, menarche was associated with a significant rise in the mean serum LH concentration. These findings indicate that the correlation between changes accompanied with puberty and increased LH levels in girls is more clearly manifested than in boys. (auth)

26166 DETERMINATION OF SMALL AMOUNTS OF ZIRCONIUM IN SOME TECHNICAL ALLOYS BY X-RAY FLUORESCENCE OF ZIRCONIUM PHENYLARSONATE. Brill, M. (Vereinigte Deutsche Metallwerke AG, Frankfurt am Main). Z. Anal. Chem., 244: 36-8(1969). (In German).

Zirconium may be separated to a highly selective degree by phenylarsonic acid from strong acid aqueous solutions of aluminum-, copper-, chrome–nickel–iron-, and iron-base alloys. The precipitation film deposited on Millipore Filters is suitable for determining zirconium by x-ray fluorescence. Concentrations of zirconium were determined in the range of 0.002 to 1% by this method. (auth)

26167 SPECTROPHOTOMETRIC DETERMINATION OF NIOBIUM IN PLATINUM–NIOBIUM ALLOYS. Geissler, M.; Lorenz, G. (VEB Bergbau- und Huettenkombinat Albert Funk Forschungsinstitut, Freiberg, Ger.). Z. Anal. Chem., 244: 235-40(1969). (In German).

The method employs pyrogallol as reagent and is suitable for the determination of 0.1 to 1.0% of niobium. Separation of platinum from niobium is achieved by dissolving the alloy in aqua regia and precipitating the dissolved niobium by addition of cupferron. The effect of platinum on the spectrophotometric determination of niobium using 4-(2-pyridylazo)resorcinol(PAR), bromopyrogallolred-(BPR), and pyrogallol is studied in detail. (auth)

26168 DETERMINATION OF SMALL QUANTITIES OF MOLYBDENUM IN METALLIC VANADIUM AND VANADATES. Klug, O.; Metlenko, S. Kohaszat, 101: 139-43(1968).

The molybdenum content of vanadium metal and vanadates was concentrated and separated by ion exchange and extraction methods. About 0.05% of Mo the Hungarian Varion AD resin gave satisfactory results. For the separation of Mo in quantities of the order of 10 ppM extraction with diethyl ether or diisopropyl ether is preferred. The molybdenum concentrated in this way is then extracted again after reduction in the presence of SCN ions and its absorption measured in the organic phase at 465 nm. According to the analytical results of some metal samples 4 to 30 ppM of molybdenum can be determined with 20% relative error. (Hung. Tech. Abstr.)

26169 MASS SPECTROMETRIC MEASUREMENT OF ^{15}N ENRICHMENT IN NITROGEN OBTAINED BY DUMAS COMBUSTION. Desaty, D.; McGrath, R.; Vining, L. C. (National Research Council of Canada, Halifax, Nova Scotia). Anal. Biochem., 29: 22-30(Apr. 11, 1969).

A rapid, accurate Dumas method for determining ^{15}N enrichments of from 0.37 to 100% is described. Whereas compounds with only one nitrogen atom exhibit random pairing in the nitrogen molecule formed during combustion, equilibration is incomplete in compounds with two or more variously bonded (N–N, O–N, and C–N) nitrogen atoms. Failure to equilibrate is presumed to result from differences in bond energy between nitrogen and adjacent atoms. It is an advantage in revealing unequal enrichments of the nitrogen atoms present and in detecting nitrogenous impurities. (auth)

26170 VOLUMETRIC DETERMINATION OF THORIUM AND CERIUM WITH EDTA USING MUREXIDE AS INDICATOR. Malik, Wahid U.; Sharma, C. L.; Ashraf, Y. (Univ. of Roorkee, India). Z. Anal. Chem., 244: 315(1969).

In the titration of Ce(III) and Th(IV) with EDTA, murexide can be used as indicator. There is a distinct color change in the end point from yellowish to deep pink. The titration can be performed at room temperature and the concentration of the sample solutions should be about 0.1 M in order to assure a sharp change of color. Best results will be obtained if the pH of the solution is within the range of 1.5 to 3.0. The following ions cause serious interferences: Ag^+, Cu^{2+}, Fe^{3+}, Ce^{4+}, F^-, SO_3^{2-}, $C_2O_4^{2-}$, and PO_4^{3-}. (auth)

26171 PAPER CHROMATOGRAPHIC SEPARATION AND SPECTROPHOTOMETRIC DETERMINATION OF TRACE AMOUNT OF ZIRCONIUM. Harasawa, Shiro; Matsusaki, Koki (Yamaguchi Univ., Japan). Yamaguchi Daigaku Kogakubu Kenkyu Hokoku, 19: No. 2, 21-4(Nov. 1968). (In Japanese).

Zirconium can be separated from other metals by ascending paper chromatography with EtOH–AcOEt–H_2O–HCl (10 : 20 : 10 : 1 by volume), EtOH–BuOH–H_2O–HCl (4 : 6 : 5 : 1), isoPrOH–H_2O–HCl (20 : 11 : 1) or isoPrOH–AcOEt–H_2O–HCl (20 : 5 : 11 : 1) solvent system. The separated zirconium was eluted completely from the chromatogram section by dropping 20 ml of concentrated hydrochloric acid with a burette. The eluted solution was transferred to a 50-ml volumetric flask, to which 13 ml of hydrochloric acid, 5 ml of gelatin solution, and 3 ml of 0.3% Arsenazo III solution were added. After 30 minutes, the absorbence was measured at 665 mμ against water. Satisfactory results were obtained with 0.5 to 20 μg zirconium. (NSA of Japan)

26172 THE SEPARATION OF NEON FROM HIGH-HELIUM-CONTENT NATURAL GASES AND THE ATMOSPHERE FOR ISOTOPIC ANALYSES. Emerson, David E.; Suttle, Elmer T.; Hoffman, C. A. (Helium Research Center, Amarillo, Tex.). J. Mass Spectrom. Ion Phys., 1: 105-10(June 1968).

The determination of the isotopic composition of neon from natural gases and the atmosphere was studied. The apparatus and method described concentrates neon directly from high-helium-content natural gases or from the atmosphere by utilizing two adsorption traps of activated coconut charcoal at 30 and 77°K. Using this method, a survey was made of the isotopic composition of neon in natural gases. The results confirmed the presence of excess ^{21}Ne and supported the belief that neon is produced in the Earth's crust in the course of extensive nuclear processes. Results agreed with those previously obtained using a different method of separation. The concentration relationship between ^{4}He and $^{21}Ne_{(rad)}$ ($^{4}He/^{21}Ne_{(rad)}$) was found to be approximately 4×10^7. A redetermination of the isotopic composition of atmospheric neon gave percentage abundances of ^{20}Ne, 90.61 ± 0.03; ^{21}Ne, 0.264 ± 0.003; and ^{22}Ne, 9.13 ± 0.03. These percentages correspond to ratios of $^{20}Ne/^{22}Ne = 9.92 \pm 0.03$ and $^{20}Ne/^{21}Ne = 343.2 \pm 3.9$. (auth)

26173 FERROUS METALLURGY. Pasztor, L. C.; Hines, C. R. (Jones and Laughlin Steel Corp., Pittsburgh). Anal. Chem., 41: No. 5, 90R-101R(Apr. 1969).

Literature published from Dec. 1966 to Nov. 1968 is reviewed. Procedures were found to be largely refinements of existing procedures. Methods for the determination of the following elements in iron or steel are reviewed: Al, Sb, As, Be, Bi, B, Ca, C, Cr, Co, Cu, Ga, H, N, O, Ge, Hf, In, Pb, Mg, Ni, Nb, Ta, P, Se, Si, S, Te, Sn, Ti, W, V, Zn, Zr, and rare earths. Uses of spectroscopic techniques, including atomic absorption, nuclear, optical emission, and x-ray electron microprobe, for ferrous metallurgical analyses are included. (580 references). (J.G.B.)

26174 NONFERROUS METALLURGY. I. LIGHT METALS: ALUMINUM, BERYLLIUM, TITANIUM, AND MAGNESIUM. Oliver, Richard T.; Cox, Ernest P. (Aluminum Co. of America, New Kensington, Pa.). Anal. Chem., 41: No. 5, 101R-11R (Apr. 1969).

Literature published from Sept. 1966 through Aug. 1968 on the metallurgical analyses of Al, Be, Ti, and Mg and their alloys is reviewed. (266 references). (J.G.B.)

26175 NONFERROUS METALLURGY. II. ZIRCONIUM, HAFNIUM, VANADIUM, NIOBIUM, TANTALUM, CHROMIUM, MOLYBDENUM, AND TUNGSTEN. Bachman, Robert Z.; Banks, Charles V. (Iowa State Univ., Ames). Anal. Chem., 41: No. 5, 112R-40R(Apr. 1969).

A review is presented on literature published from July 1966 to July 1968 on methods for the determination of Zr, Hf, V, Nb, Ta, Cr, Mo, and W. (821 references). (J.G.B.)

26176 WATER ANALYSIS. Fishman, M. J.; Robinson, B. P. (Geological Survey, Denver). Anal. Chem., 41: No. 5, 323R-60R(Apr. 1969).

Literature on methods of water analysis is reviewed for the period, Oct. 1966 through Sept. 1968. (664 references). (J.G.B.)

26177 POTENTIOMETRIC DETERMINATION OF MANDELIC ACID AND ZIRCONIUM MANDELATES WITH VANADIUM(V). Mathur, D. L.; Bhansali, G. R.; Rao, S. P. (Jodhpur Univ., India). J. Electroanal. Chem., 15: 315-16(1967).

The direct oxidimetric determination of mandelic acid and zirconium tetramandelate with vanadium(V) is described. Potentiometric methods were used for locating the end point since the oxidation of mandelic acid may still be a slow process. The use of the potentiometric end-point also eliminated the rigorous control of sulfuric acid concentration, necessary in visual titration. In the determination of zirconium, 16 equivalents of oxidant/mole of zirconium are consumed, and the method can be employed for determining trace amounts of zirconium where gravimetric methods do not give the accuracy. (Indian Sci. Abstr.)

26178 DETERMINATION OF THE ISOTOPE RATIO OF LEAD SAMPLES USING ATOMIC ABSORPTION. Kirchhof, H. (Univ., Giessen, Ger.). Spectrochim. Acta, Part B, 24: 235-41 (Apr. 1969). (In German).

An optical method is described for the determination of the stable isotopes of lead in small samples using the absorption of the hyperfine components of the 4058 Å and the 2833 Å resonance lines. Hollow cathode lamps containing different mixtures (different standards and the probe) of lead are used as sources of the hyperfine components. By determining the absorption of the ^{208}Pb (^{206}Pb) component by lead vapor consisting only of ^{208}Pb (^{206}Pb) the quantity of ^{208}Pb (^{206}Pb) present in the probe can be determined. The absorbing vapor is produced by cathodic sputtering in the adsorption hollow cathode lamp. The analyses of geological samples containing various percentages of ^{208}Pb and ^{206}Pb agree with values obtained by mass spectrometric methods within 2%, which is the accuracy of the method used. (auth) (UK)

26179 FALLOUT MONITORING OF WATERS. II. RADIOCHEMICAL DETERMINATION OF ^{144}Ce, ^{137}Cs, ^{89,90}Sr, AND

^{140}Ba BY ION-EXCHANGE. Senegacnik, M.; Paljk, S. (J. Stefan Nuclear Inst., Ljubljana, Yugoslavia. Univ. of Ljubljana, Yugoslavia). Z. Anal. Chem., 244: 375-9(Mar. 20, 1969).

A method for the rapid determination of ^{144}Ce, ^{137}Cs, ^{89}Sr, and ^{140}Ba in surface waters and atmospheric water precipitations by ion exchange is presented. It can be applied to samples with total calcium and magnesium content up to 110 meq. The limits of detection are 0.005 pico Ci/l for ^{144}Ce, 0.006 pico Ci/l for ^{137}Cs, 0.004 pico Ci/l for ^{90}Sr, and 0.006 pico Ci/l for ^{140}Ba with a 30 l sample. These sensitivities can be improved by use of a battery of columns. (auth)

26180 DETERMINATION OF ALKALINE EARTHS BY ION-EXCHANGE. Senegacnik, M.; Paljk, S.; Korosin, J. (J. Stefan Nuclear Inst., Ljubljana, Yugoslavia. Univ. of Ljubljana, Yugoslavia). Z. Anal. Chem., 244: 365-7(Mar. 20, 1969).

An ion exchange method for determination of magnesium, calcium, strontium, and barium in mixtures containing up to 6 meq. of each is presented. The separation of (Mg + Ca) – Sr – Ba was performed on a column filled with Dowex 50 W, X-8 by 0.6$\underline{M}$ ammonium glycolate – 0.2$\underline{M}$ NaCl, pH 5 and 1.2$\underline{M}$ ammonium glycolate – 0.4$\underline{M}$ NaCl, pH 5 as eluents. Calcium was separated from magnesium by precipitation as oxalate and determined by titration with permanganate. Magnesium was isolated as magnesium ammonium phosphate and determined acidimetrically. Strontium and barium were precipitated as carbonates and then weighed or determined by EDTA titration. The errors of determination did not exceed ±2%. (auth)

26181 SPECTROGRAPHIC DETERMINATION OF TUNGSTEN AND MOLYBDENUM IN TUNGSTEN–MOLYBDENUM ORES AND TAILINGS FROM BENEFICIATION PLANTS. Salcheva, Mariya; Belchev, Belcho; Tencheba, Radka. Rudodobiv Met. (Sofia), 23: 15-18(Jan. 1968). (In Bulgarian).

A spectrographic method for the simultaneous determination of W (0.002 to 0.2%) and Mo (0.001 to 0.5%) in ores and tailings, using a medium-dispersion quartz spectrograph and Al electrodes of special shape is described. The relative error for the above concentrations is 7.7% for W and 12% for Mo. (14 references). (Metals Abstr.)

Isotopic Procedures

26182 ON THE ISOTOPIC ANALYSES OF OXYGEN AND CARBON OF MARINE BIOGENIC CARBONATES SUCH AS CORALS AND PELECYPODS. Nakamichi, Osamu (Kanazawa Univ., Japan); Sakai, Hitoshi. Shitsuryo Bunseki, 17: 500-8(Mar. 1969). (In Japanese).

Corals and peiecypods of Recent to Pleistocene age were analyzed for their isotopic ratio of O and C by means of McCrea's technique. The precision and reproducibility of the isotopic analysis were found to be ±0.08% for δ^{18}O and ±0.15% for δ^{13}C based on the analyses of NBS-20 limestone over a period of six months. The effect on the isotopic ratio of roasting present-day and fossil carbonates in purified He was also examined. It was shown that the diagenetic alteration of aragonite skeleton of Pleistocene corals resulted in the depletion of ^{13}C in parallel with calcitization and dissolution of uranium. (NSA of Japan)

Radiometric Procedures

26183 (AEEW-M-807) MEASUREMENT OF DEPLETION OF NOMINALLY 0.04 PERCENT DEPLETED URANIUM METAL FOIL BY TWO DIFFERENT METHODS. Millington, R. A.; Taylor, W. H.; Webber, P. J. (Atomic Energy Establishment, Winfrith (England)). Feb. 1968. 9p. Dep. CFSTI.

A depleted uranium foil sandwiched between similar foils is irradiated in a pure thermal spectrum together with a similar pack of natural uranium foils. The relative activity induced is then measured by gamma spectrometry. In a second method, two platinum discs with very thin deposits of depleted and natural uranium are mounted in either side of a "back-to-back" double fission chamber, which is then irradiated in a thermal column. Measurements on the same material by the two methods showed agreement to better than 1%. (UK)

26184 (CEA-R-3708) APPLICATION OF GAMMA ABSORPTIOMETRY TO THE ANALYSIS OF URANIUM IN SOLUTIONS. Lavaud, Michel (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). Feb. 1969. 30p. (In French). Dep.

A gamma-ray absorptiometric apparatus for the determination of uranium or plutonium in solution was built and studied. Results obtained by the method and possible developments are given. (auth)

26185 CONTINUOUS MEASUREMENT OF α-EMITTING NUCLIDES IN ELUTION CHROMATOGRAPHY EMPLOYING FLEXIBLE PLASTIC-TUBE SCINTILLATORS. Specht, S.; Hoehlein, G.; Weinlaender, W. (Technische Hochschule, Munich). Z. Anal. Chem., 244: 161-5(1969). (In German).

The method described permits the direct measurement of α-activity in solution with relatively high sensitivity. The eluting agent is passed through a specially designed column and through the plastic scintillator by means of a flexible tubing pump. The device works automatically after applying the activity and there is less danger of contamination than with other methods. The separation can also be performed on a preparative scale as the single nuclide fractions are obtained in solution and in a defined stage of oxidation and are ready for immediate further processing. (auth)

26186 ANALYTICAL AND RADIOMETRIC DETERMINATION OF SMALL AMOUNTS OF $^{14}CO_2$. Roesseler, M.; Koch, H. (Institut fuer Angewandte Radioaktivitaet, Leipzig). Z. Anal. Chem., 244: 169-72(1969). (In German).

After absorption in an aqueous solution of 0.1 $\underline{N}$ barium hydroxide, the carbon dioxide is determined with an accuracy of ±0.3% by back titration of the excess base. From the ^{14}C-containing barium carbonate formed, the carbon dioxide is liberated again with concentrated sulfuric acid in vacuo, and its specific activity is determined. The measurement of activity is performed with a vibrating reed electrometer in an ionization chamber. The mean error of the average value of the activity determination is ±0.5%. (auth)

26187 FALLOUT MONITORING OF WATERS. I. RADIOCHEMICAL DETERMINATION OF ^{137}Cs AND $^{89\ 90}$Sr BY ION-EXCHANGE. Senegacnik, M.; Paljk, S. (Nuclear Inst. Jozef Stefan, Ljubljana, Yugoslavia. Univ., Ljubljana, Yugoslavia). Z. Anal. Chem., 244: 306-9(1969).

A rapid ion-exchange method for the determination of ^{137}Cs, ^{89}Sr, and ^{90}Sr in water samples, containing up to 110 meq. of calcium–magnesium, is described. With a 30-l sample the limit of detection amounts to 0.006 pCi/l for ^{137}Cs and 0.004 pCi/l for ^{90}Sr. By using instead of a single column a battery of columns the limits of detection can be reduced a few more times. (auth)

26188 APPLICABILITY OF BETA RADIATION BACK-SCATTERING IN ANALYTICAL CHEMISTRY. Jirkowsky, Rudolf. Freiberg. Forschungsh., No. 130B, 50(1968). (In German).

Theory of and equipment for the method are reviewed, relations between absorption and backscattering of β radiation and atomic number of the element concerned are discussed. Applications include the determination of ash content of coal, Fe + Mn in Fe ores, Cr in Cr ore and slags, W in slags, Si and Al in Fe–Si and W in Fe–W and steel, C in graphite, Pb in solder, Sb in hard Pb alloy, and Fe in blast-furnace agglomerate (mean arithmetic error ~±0.9% for 86 different samples). An automatic β detector for the determination of the ash content of coal is described. Eighty-eight references are cited. (Metals Abstr.)

26189 DETECTION OF WEAK BETA EMITTERS BY LIQUID SCINTILLATION COUNTING TECHNIQUES. PART 2. SOME PHENOMENA OBSERVED IN THE PRESENCE OF GASES IN LIQUID SCINTILLATION SYSTEMS. Torok, Gabor; Nagy, Lajos Gyorgy; Szarvas, Tibor (Polytechnic Univ., Budapest. Inst. for Isotopes, Budapest). Period. Polytech. Chem. Eng., 12: 229-43(1968). (In Hungarian).

The liquid scintillation system, the scintillation solution, the sample, the $^{14}CO_2$ counting with the aid of Hyamine 10-X, and the effects of gases dissolved in scintillator solutions are described. The gases investigated included ethylene, CO_2, and NH_3. These gases or their compounds may also be directly or indirectly excited, taking part in the energy transfer. Fourteen references are cited. (JPRS)

26190 DETERMINATION OF URANIUM, RADIUM, THORIUM, AND POTASSIUM IN VARIOUS ROCKS OF THE VOSGES BY GAMMA SPECTROMETRY WITH THE HELP OF A LITHIUM-COMPENSATED GERMANIUM DETECTOR. Mathevon, Gilbert (Institut de Physique du Globe, Strasbourg. Centre de Recherches Nucleaires, Strasbourg). Compt. Rend., Ser. A, B, 268: 353-6 (Jan. 27, 1969). (In French).

A gamma spectrometer was used to determine radioactive elements in 30 samples of Vosges rocks. The method of least squares was used to determine the concentrations of radium, thorium, and potassium, and the radiation at 92 keV emitted by $^{234}Th_{90}$ was chosen to standardize the uranium. (tr-auth)

26191 ALPHA EMITTERS IN FOODS. Kawai, Hiroshi; Honda, Yoshihide (Kinki Univ., Osaka). Kinki Daigaku Genshiryoku Kenkyusho Nenpo, No. 6, 15-19(1967). (In Japanese).

The alpha-ray activities were determined in foods by a radiochemical method. The successive ion exchange separation of uranium in foods is discussed. The following results were obtained: recovery of uranium by the method was 78.3 ± 3.8% on the average; contamination of other nuclides was not found in a separated fraction and separation of uranium was performed almost perfectly; and the uranium content in some vegetation was determined. It was found that the uranium content of vegetables was somewhat greater than the content in cereals, green tea ("Ban-tya"), and potatoes. (NSA of Japan)

26192 QUANTITATIVE DETERMINATION OF TWO-COMPONENT MIXTURE OF RADIONUCLIDES. Gureev, E. S.; Islamov, T.; Muminova, M. F.; Miroshnikova, V. S. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk, No. 4, 56-7(1968). (In Russian).

A quantitative analysis of a ^{186}Re and ^{99}Mo mixture was achieved by measuring the ratio of β- and γ-activity using two corresponding particle detectors. Tabulated data on the analysis of the ^{99}Mo, ^{186,188}Re showed $K_1 = 12.15 \pm 0.12$ and $K_2 = 1.86 \pm 0.04$, respectively, indicating effective quantitative determination of radioisotopes without radiochemical separation. (R.V.J.)

26193 NEUTRON RESONANCE METHOD FOR DETERMINATION OF SILVER. Vakhtin, B. S.; Filippov, E. M. Tsvetn. Metal., No. 12, 14-16(Dec. 1968). (In Russian).

The method for determination of silver using a neutron resonance apparatus by recording resonant neutrons with a detector manufactured from a silver foil is considered. The determination was conducted using the short-lived ^{110}Ag isotope (half-life of 24.2 sec). A neutron source of 10^7 neutrons/sec was used. The relation for the concentration of silver in the range from 0 to 0.25% is linear. The accuracy and sensitivity of the method are ~0.05% (abs). The time necessary for one analysis is 6 to 7 minutes. An increase in accuracy and sensitivity is possible by utilization of a more powerful neutron source. (tr-auth)

Activation Procedures

Refer also to abstract 26371.

26194 (CEA-Bib-116) ACTIVATION DETERMINATION OF OXYGEN AND NITROGEN IN SOLIDS. APPLICATION TO THE STUDY OF SURFACE REACTIONS. Berry, Laure (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1968. 25p. (In French). Dep.

The various methods for determining small amounts of oxygen and nitrogen in metals by activation analysis are examined. The examples given show that, in the actual state of the technique, only the methods based on the use of γ photons and charged particles make it possible to carry out accurate determinations. Also, the data acquired in the field of surface analysis over the last few years are gathered together. More particular consideration is given to the determination of the oxygen concentration profile in the surface layers formed during the oxidation of metals. (auth)

26195 (RT/CHI-(69)1) QUANTITATIVE NONDESTRUCTIVE DETERMINATION BY MEANS OF ACTIVATION WITH THERMAL NEUTRONS OF MANGANESE, OF POTASSIUM, AND OF SODIUM IN GENOTYPES OF PISUM AND THEIR PRELIMINARY STATISTICAL DIFFERENTIATION ON THE BASIS OF RESULTS OBTAINED. Moauro, A.; Capannesi, G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1969. 42p. (In Italian). Dep.

Descriptions of methods are given for the determination of Mn, Na, and K in samples of a Pisum genotype, and the results were correlated with different samples. Nuclear activation measurements were made using a NaI(Tl) detector for Mn and a Ge(Li) detector for Na and K directly of their radiation fields and avoiding any chemical procedures. Determination of the above elements was made with samples of 0.1 to 0.2 g for each genotype. The results of the determination were followed by the statistical method of Wilcoxon which made possible the separation of various classes of notably diverse contents of Mn and K. (tr-auth)

26196 (VNIIRT-2) ACTIVATION DETERMINATION OF INDIUM, SELENIUM, FLUORINE, AND OTHER ELEMENTS IN A STREAM OF SOLUTIONS. Kartashev, E. R.; Shtan', A. S. (Vsesoyuznyi Nauchno-Issledovatel'skii Institut Radiatsionnoi Tekhniki, Moscow (USSR)). 1968. 18p. (In Russian). Dep.

The design of the installation and procedures are described for continuous automatic neutron activation with a ^{239}Pu-Be source (~5 × 10^6 neutron/sec). A scintillation counter with a 80 × 80 mm NaI(Tl) crystal and a complex of recording instruments were also used for determining In, V, Mn, Se, Al, and F in solutions. Experimental data obtained on the thresholds of neutron activation determination of the elements in solutions forming ^{116m}In, ^{52}V, ^{56}Mn, ^{77m}Se, ^{28}Al, and ^{16}N are tabulated. (R.V.J.)

26197 STUDY OF PRECIPITATION IN NEUTRON ACTIVATION ANALYSIS. IV. SEPARATION OF ARSENIC(V) SULPHIDE OR SILVER ARSENATE IN DETERMINATION OF ARSENIC IN BIOLOGICAL MATERIAL. Rakovic, M. (Charles Univ., Prague). Chem. Zvesti, 23: 147-9(1969).

The possibility of determining arsenic in animal tissues by simple precipitation separation of arsenic(V) sulfide or silver arsenate is studied. The decay curves obtained from measurements carried out by a scintillation counter indicate radiochemical purity, which, for practical purposes, is quite satisfactory. The precipitation of silver arsenate is less suitable since a greater part of the radiophosphorus ^{32}P occurs in the solid phase. (auth)

26198 NONDESTRUCTIVE ACTIVATION ANALYSIS OF HIGH-PURITY ALUMINIUM FOR URANIUM AND SOME OTHER IMPURITIES. Van Reenen, T. J.; De Wet, W. J. (National Nuclear Research Center, Pelindaba, S. Afr.). J. S. Afr. Chem. Inst., 21: 120-6(Oct. 1968).

In an investigation of the energy distribution of various fission fragments recoiling from unclad U fuel, Al collimators were used as catchers in a stacked arrangement. Fission in the U foil was induced by neutron irradiation in a reactor, which also activated impurities present in the Al metal. Analysis was made of batches of high-purity Al by nondestructive neutron activation and γ spectrometry using a computer stripping program. Since fission fragment distribution patterns were to be measured only after a 2 weeks' cooling interval, the Al samples were also allowed to cool for 2 weeks between irradiation and activity measurements. Trace quantities of U, Sc, Au, Cr, and Sb were determined. The U concentration found for 2S aluminum agreed closely with the earlier reported value of about 1.8 ppM. Very high quality Al (99.9999%) definitely also contained U. (BBB)

26199 DETERMINATION OF IMPURITIES IN IRON BY NEUTRON ACTIVATION. Artyukhin, P. I.; Gilbert, E. N.; Pronin, V. A. (Inst. of Inorganic Chemistry, Novosibirsk, USSR). Zh. Anal. Khim., 22: 111-13(1967). (In Russian).

A method is proposed for the determination of Co, Cu, In, Zn, As, Te, and Sn in high-purity iron. After irradiation of the sample in a neutron flux of ≃1.8 × 10^{13} n/cm^2/sec for 8 hr the Fe is separated by extraction into 2-chloroethyl ether from 11.4 $\underline{M}$ HCl. The impurities remaining in the aqueous phase are transferred to 6$\underline{M}$ HF medium and applied to a column of Dowex 1 resin (F^- form). The percolate contains Co, Cu, In, and Zn, which are determined by γ spectrometry without further separation. Arsenic, Te, and Sn are eluted with 17 $\underline{M}$ HF, transferred to 6.5$\underline{M}$ HCl medium and applied to a column (Cl^- form) from which they are successively eluted with 11 $\underline{M}$ HCl, 0.1$\underline{M}$ oxalic acid, and 0.2$\underline{M}$ oxalic acid-2$\underline{M}$ NH_4NO_3, respectively. Each of these elements is then determined by comparing its activity with that of the corresponding standard. For ≃0.1 ppM of each impurity, the reproducibility was within ±10%. (Anal. Abstr.)

26200 APPLICATION OF NON-DESTRUCTIVE ACTIVATION ANALYSIS TO METEORITES: DETERMINATION OF ALUMINUM, VANADIUM, MANGANESE, AND GOLD IN STONY AND IRON METEORITES. Hoefler, H.; Sorantin, H. (Reactorzentrum, Seibersdorf, Austria. Atomenergie GmbH, Seibersdorf, Austria). Chem. Geol., 2: 273-8(1967).

The samples (50 to 100 mg) enclosed in polyethylene containers are irradiated for 2 (for Mn) or 20 min in a reactor with a thermal-neutron flux of ≃5 × 10^{12} n/cm^2/sec and a fast-neutron flux of ≃5 × 10^{10} n/cm^2/sec, samples and standards being irradiated one after another. The samples and standards are then counted by using a NaI(Tl) crystal (3 in. × 3 in.) with a 400-channel pulse-height analyzer. For Al the 1.78-MeV peak is used; the reaction ^{28}Si(n,p)^{28}Al contributes to the ^{28}Al activity and this must be corrected for by simultaneously irradiating SiO_2 standards of an Si content similar to that of the sample. For V the 1.44-MeV peak is used. Standards for Al and V are prepared from high-purity Al foil and from steels with different V contents. For the determination of Mn the 0.84-MeV peak is used: the precision is ±5%; $MnSO_4$ absorbed on filter-paper is used as standard. For Au all the pulses lying in the channel section above the half width of the peak at 0.480 Mev are summed and compared with values of standard spectra from high-purity Au. Results are given for 9 meteorites: they deviate up to ≃20% from values obtained by x-ray emission spectrometry, this being the same order of magnitude as variations of the neutron flux. (Anal. Abstr.)

26201 NEUTRON ACTIVATION ANALYSIS OF POTTERY SHERDS FROM HAJAR BIN HUMEID AND RELATED AREAS. Al Kital, R. A.; Chan, Lui-heung; Sayre, Edward V. (Brookhaven National Lab., Upton, N. Y.). pp 387-98 of Hajar Bin Humeid: Investigations at a Pre-Islamic Site in South Arabia. Van Beek, Gus W., (ed.). Baltimore, Johns Hopkins Press, 1969.

A group of 41 pottery sherds from 4 different archeological regions in Ethiopia were analyzed by nondestructive neutron activation analysis. The purpose of the study was two-fold: (1) to study the correlations existing in the composition of the sherds, which might indicate a common origin for correlating specimens, and (2) to investigate the number of elements that could be determined nondestructively by neutron activation with γ spectra measured by the new Li-drifted, Ge-diode radiation detectors. It was found that the following 12 elements could be determined: Al, Sc, La, Eu, Ce, Hf, Th, Cr, Mn, Fe, Co, and Na. However, the samples were not analyzed for Na because the Na content of the samples could have been so altered by penetration of salts from the soil, by past washings, and by a preliminary leaching treatment. The sherds were all found to have basically similar compositions, and the mean abundances of the oxides measured were, in general, close to estimates that have been made of the average abundance of the same oxides in the igneous rocks of the earth's lithosphere. The results are presented in detail in tabular form. (B.L.M.)

26202 VARIOUS METHODS FOR THE DETERMINATION OF TRACE ELEMENTS. Erdey, Laszlo (Budapest Technical Univ.). Kem. Kozlem., 30: 372-8(Dec. 30, 1968). (In Hungarian).

Methods used for the determination of trace elements include optical, titrimetric, gas chromatographic, electrical, radiochemical, gravimetric + thermal, and kinetic techniques. Activation analysis is more suitable than any of these in terms of sensitivity, accuracy, reproducibility, and selectivity; thus it should be employed wherever practicable. (JPRS)

26203 AUTOMATIC DETERMINATION OF ALUMINA AND SILICA IN BAUXITE SAMPLES BY NEUTRON ACTIVATION. Tatar, J. Banyaszat, 101: 287-91(1968). (In Hungarian).

An automatic neutron activation analyzer consisting of a central control panel, sample store and activator, dosimeter and polonium–beryllium neutron source was constructed for the analysis of bauxite samples. Since ^{28}Al can be produced by both Al_2O_3 and SiO_2 nuclear processes induced by rapid and by thermal neutrons had to be separated for quantitative determinations. Ten grams each of the substance under investigation are weighed into plastic tubes the samples being kept in the storing section up to the beginning of activation. Activation lasts 5 min. To achieve homogeneous irradiation of the sample surface the sample is rotated about its axis during the period of activation. After activation the sample is delivered to the measuring section containing lead-shielded GM counters where the beta and gamma radiations of the samples are measured. Measuring takes 2 min. The result appearing on the scaler is automatically printed for each sample, thus the quality and homogeneity of the used bauxite can also be established retrospectively. Analysis of bauxite by neutron activation is less time consuming and furnishes more accurate results than the earlier wet chemical methods. (Hung. Tech. Abstr.)

26204 PHOTOACTIVATION ANALYSIS OF PVC SHEETS. Miki, Ryota (Kinki Univ., Osaka); Azuma, Toshio. Kinki Daigaku Genshiryoku Kenkyusho Nenpo, No. 6, 1-4(1967). (In Japanese).

The amounts of additive elements in PVC (Polyvinyl chloride) sheets were determined nondestructively, by irradiating PVC sheets and their additive agents with the Bremsstrahlung from ORC (Radiation Center of Osaka Prefecture) Electron Linac. The results obtained by gamma spectra measurements of the activated radioisotopes are reported. (NSA of Japan)

26205 RADIOACTIVATION METHOD FOR DETERMINING TRACES OF Pd IN SOME CONCENTRATES AND ORES BY SUBSTOICHIOMETRIC SEPARATION. Abdusalyamov, N.; Ganiev, A. G.; Nazmitdinov (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk, No. 4, 53-5(1968). (In Russian).

A neutron-activation method of determination of Pd in copper–nickel concentrates was developed using diethyl dithiophosphoric acid and based on ^{109}Pd extraction as the diethyl dithiophosphate; the coefficient of separation from various impurities (silver, platinum, copper, etc.) was $\approx 10^5$, with 99.9% Pd extraction into the organic layer after the first cycle. Tabulated data of specimens irradiated for 8 hr by a thermal neutron flux of $\approx 10^{13}$ neutr · cm/sec showed that the method can effectively determine small quantities of Pd with a sensitivity of 1×10^{-7} g. (R.V.J.)

26206 AKTIVATSIONNYI ANALIZ CHISTYKH MATERIALOV. (Activation Analysis of Pure Materials). Zverev, B. P. Tashkent, Izdatel'stvo Fan Yzbekskoi SSR, 1968. 96p.

Radiochemical methods and instruments used in the activation analysis of pure metals, and compounds are described in 18 separate articles. Some of the elements determined by neutron activation analyses include B, Au, Mo, Pd, Ta, Ru, In, and W. Gamma spectra of elements obtained using 14.5-MeV neutrons are presented. (R.V.J.)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 26264, 26313, 26338, 27151, 27704, 27711, 27926, and 28652.

26207 (AERE-Bib–163) LIST OF UNCLASSIFIED DOCUMENTS, LECTURES, ETC., BY THE STAFF OF THE CHEMISTRY DIVISION AND THE APPLIED CHEMISTRY DIVISION, A.E.R.E., HARWELL, 1968. Dawes, M. J. (comp.) (Atomic Energy Research Establishment, Harwell (England)). Jan. 1969. 16p. Dep. CFSTI. UK 3s. 0d.

A list of 114 reports, memoranda, conference papers, books, lectures, and journal papers is given. (UK)

26208 (AERE-Trans–1110) POTENTIOMETRIC MEASUREMENTS IN FUSED SALTS: THE PRINCIPLE AND THE CONSTRUCTION OF AN OXYGEN ELECTRODE HAVING A $Th_{0.8}Y_{0.2}O_{1.9}$ SOLID ELECTROLYTE MEMBRANE WHICH CONDUCTS OXIDE IONS. Eichler, B.; Naumann, D.; Ullmann, H. Translated by R. Todd (Atomic Energy Research Establishment, Harwell, Eng.), from Z. Phys. Chem. (Leipzig), 236: 372-7(1967). 7p. Dep. CFSTI. UK 1s. 9d.

An abstract of this paper, prepared from the original language, appeared as NSA 22: 25350.

26209 (ANL–7550, pp 35-73) MATERIALS CHEMISTRY AND THERMODYNAMICS. (Argonne National Lab., Ill.).

Vapor pressure studies on the U–Pu–O, U–Pu–C, Pu–O, Pu–C, and U–C systems are reported. Phase diagrams were prepared for the U–Pu–O system. Enthalpies for Na_3Bi and UB_2 were determined. Studies on the chemical and physical properties of irradiated UO_2-PuO_2 clad in stainless steel are reported. The feasibility of using mixtures of xenon isotopes as tags for the identification of fuel elements that fail in a nuclear reactor was investigated. Room-temperature enthalpies of formation were determined for UB_2, US_2, PuN, PuC, liquid HF, IF_5, IF_7, GeF_4, and B_2O_3. Studies on the enthalpy of $KBrO_4$ were initiated. Some physicochemical properties of liquid sodium were studied. (J.G.B.)

26210 (BNWL–1017) OXIDATION OF NEPTUNIUM(V) IN NITRIC ACID SOLUTION: LABORATORY STUDY OF RATE ACCELERATING MATERIALS (RAM). Swanson, J. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 1969. Contract AT(45-1)-1830. 29p. Dep. CFSTI.

Oxidation of neptunium(V) to neptunium(VI) can be accelerated by the addition of "Rate Accelerating Materials" (RAM). These materials that accelerate oxidation of neptunium(V) in HNO_3-HNO_2 solutions are obtained by reacting the aci-form of 1-nitropropane with HNO_3 in the presence of nitrite. The preparation of this material and its effect on the oxidation rate were studied in detail. The data indicate that addition of a low concentration of RAM could increase the rate of neptunium(V) oxidation by several orders of magnitude. The extractability and stability to radiation of RAM appear to be adequate for plant use, and tests indicate that it has no effect on the solvent extraction behavior of plutonium or fission products or on phase disengaging times. (auth)

26211 (CEA-CONF–1266) FLUORIDE COMPLEXES OF HEXAVALENT NEPTUNIUM. Sontag, Rene; Musikas, Claude (Commissariat a l'Energie Atomique, Fontenay-Aux-Roses (France). Centre d'Etudes Nucleaires). [1967]. 21p. (CONF-680912–4). Dep.

From 11th International Conference on Coordination Chemistry, Haifa and Jerusalem, Israel.

Potentiometry at an imposed current can be used to determine dissociation constants of fluorhydric complexes of hexavalent neptunium. Reproducibility of the results are comparable to those obtained by other methods. The values of dissociation constants using potentiometry at null current as well as imposed current were found to be nearly the same (0.11 and 0.12, respectively). An in the case of UO_2^{2+} ions, four complexes were found. However $NpO_2F_4^{2-}$ is probably not the saturated coordinated fluorhydric complex since $NpO_2F_5K_3$ was obtained from saturated potassium fluoride solutions. Hexavalent neptunium fluorhydric complexes are less stable than the corresponding uranium complexes. This fact can be compared with the observation made for the sulfuric complexes of UO_2^{2+} and NpO_2^{2+} ions. The overall reaction $NpO_2^{2+} + FH \rightleftharpoons FNpO_2^+ + H^+$ is exothermic and occurs with a decrease in entropy. If the ΔH and ΔS values for the reaction $F^- + H^+ \rightarrow FH$ are taken into account, it can be seen that the association of NpO_2^{2+} and F^- is exothermic and occurs with a slight increase in entropy. This increase is comparable with other aqueous complexing reactions involving fluoride ions. (auth)

26212 (CONF-670649–13) SYNTHESIS OF THE ORTHO-IODOHIPPURIC ACID (HIPPURAN)–^{131}I BY EXCHANGE. del

Val Cob, M.; Rebollo, D. V. (Junta de Energia Nuclear, Madrid (Spain)). [1961]. 19p. (In Spanish). Dep.

From Symposium on Applications of Radioisotopes, Madrid, Spain.

The isotopic exchange reaction between hippuran and a solution of sodium iodide-^{131}I was studied. The effects of pH, temperature, reaction time, carrier concentration, and quantity of reducer on the reaction yield were determined. The best yield with the highest product purity was obtained at pH 6, 100°C, a reaction time of 20 hrs, and a carrier-free solution of sodium iodide-^{131}I. Modification of these conditions causes a decrease in the yield. An increase in the carrier produces in some circumstances an apparent increase in the yield, which is interpreted as the production of derivatives of hippuric acid with a higher content of iodine, because of a secondary reaction. (tr-auth)

26213 (COO-1182-27) MASS SPECTROMETRIC DETERMINATION OF DISSOCIATION ENERGIES OF PrS, GdS, AND PrO. Fries, James A.; Cater, E. David (Iowa Univ., Iowa City. Dept. of Chemistry). Apr. 3, 1969. Contract AT(11-1)-1182. 43p. Dep. CFSTI.

The dissociation energies of the gaseous molecules PrS, GdS, and PrO were determined by means of isomolecular equilibrium studies, using as reference values D_0^0(YS) = 125.7 ± 3.0 and D_0^0 (YO) = 171.8 ± 4.0 kcal/mole. Ames et al. (J. Phys. Chem. 71: 2707(1967)) previously determined the dissociation energy of PrO, and a comparison of results was made in an attempt to arrive at a "best" value. A mass spectrometric study of GdS and an earlier study of Pr_3S_4 also allow calculation of the gaseous dissociation energies of GdS and PrS. Results of these various studies are described, and best values of the dissociation energies are reported. (auth)

26214 (IFA-FN-35) PROTONIC AND DEUTERONIC MOTIONS IN PARTIALLY DEUTERATED GLYCERINE BY COLD NEUTRON SCATTERING TECHNIQUE. Rapeanu, S. (Academia R. P. R., Bucharest. Institutul de Fizica Atomica). 1968. 24p. Dep.

The cold neutron spectrometer at the Stockholm reactor R_1 was used to measure the quasi-elastic and inelastic scattering of cold neutrons on partially deuterated glycerine at 266 (glass and liquid phase), 293, 334, and 369°K. The angles of scattering, φ, ranged from 20° to 90°. The resolution of the improved instrument was 20 μs/m or 2% at 4 Å. The linewidth data as a function of the square of the moment transfers at various temperatures were compared to the theoretical linewidth curves in accordance to some dynamic models; the best fitting was with the Larsson's model. The ratios of the residence times τ_0 derived for partially deuterated glycerine and those for natural glycerine were close to $\sqrt{2}$. Also, the ratio between the frequencies of the peaks assigned to hindered rotations of the proton in the OH group in natural glycerine and of the deuteron in the OD group in partially deuterated glycerine, was found to be close to $\sqrt{2}$, as it should be if the proton and deuteron, respectively, are the dynamic units. (auth)

26215 (IS-T-301) THORIUM-THORIUM TETRACHLORIDE SYSTEM. Fuller, John Edward (Ames Lab., Iowa). Nov. 1968. Contract W-7405-eng-82. 58p. Dep. CFSTI.

Thesis.

A study was made of the Th−$ThCl_4$ system. Existence of a high-temperature allotrope of $ThCl_4$ was confirmed and x-ray powder data were obtained for this phase. The liquidus of the system was determined using a liquid solubility equilibration technique. Effects of oxygen on $ThCl_4$ were evaluated and tentative modifications of the previously reported Th_2−$ThCl_4$ phase diagram were made on this basis. Several attempts to prepare any lower chlorides of thorium were not successful. (auth)

26216 (IS-T-302) TRANSPORT REACTIONS OF THORIUM OXYDIIODIDE. Adolphson, Douglas Guy (Ames Lab., Iowa). Feb. 1969. 29p. Dep. CFSTI.

Thesis.

Traces of a remarkably voluminous red product corresponding to the composition $ThOI_2$ were found in the cooler ends of the tantalum container in an earlier study of the synthesis and properties of thorium diiodide. Since that time, Scaife and co-workers have prepared white $ThOI_2$ and described some of its properties, but they made no mention of the red modification or the migration of the compound from hotter to cooler zones. White $ThOI_2$ was obtained by the direct reaction of ThO_2 and ThI_4 in either tantalum or fused silica apparatus. The transport reaction $ThOI_2(s) + 2HI(g) = ThI_4(g) + H_2O(g)$ was established as the cause of the migration of the compound to cooler zones. The red modification was obtained when white $ThOI_2$ was heated in the presence of thorium metal in tantalum apparatus. While the means of coloration is not completely obvious, the evidence suggests that a stoichiometric excess of thorium may be responsible. (auth)

26217 (JUL-550-PC) PHOTOCHEMICAL INVESTIGATION ON AMMONIA AND AZIDE WITH THE HELP OF RADIATION GAS CHROMATOGRAPHY. Tiedemann, P.; Schindler, R. N. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Physikalische Chemie). Sept. 1968. 47p. (In German). Dep.

A radiogas chromatograph was developed for use in studies of the photochemical decomposition of nitrogen-containing compounds. Construction of the chromatograph and measurement methods using it are described. The photolysis of ammonia, hydrazoic acid, and methyl azide in the presence of ethylene was studied. (M.C.G.)

26218 (JUL-557-RG) PRODUCTION OF HYDROGEN FROM METHANE WITH THE HELP OF ATOMIC REACTOR HEAT. Kugeler, Kurt (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorentwicklung). Sept. 1968. 27p. (In German). Dep.

In the decomposition of methane with water vapor to produce hydrogen, very low hydrogen prices can be achieved if reactor heat can be incorporated in the process. A method for gas production with reactor heat and gas purification in its first passage is described. Mass and energy balances for the process, as well as cost calculations for production of hydrogen, are given. (M.C.G.)

26219 (LA-4147) A STUDY OF V(III)−V(IV) AND Ti(III)−Ti(IV) ISOTOPIC EXCHANGE REACTIONS IN ACID SOLUTIONS. PART A. LIGAND CATALYSIS OF THE V(III)−V(IV) EXCHANGE REACTION. PART B. THE Ti(III)−Ti(IV) ISOTOPIC EXCHANGE REACTION IN PERCHLORIC AND HYDROCHLORIC ACID SOLUTIONS; THE Ti(III,IV) BINUCLEAR COMPLEX IN SULFURIC ACID. Orth, Charles J. (Los Alamos Scientific Lab., N. Mex.). Mar. 1969. Contract W-7405-eng-36. 215p. Dep. CFSTI.

The rate of exchange of radioactive ^{48}V between V(III) and V(IV) has been measured in aqueous acid solutions containing various ligands including perchlorate, fluoride, chloride, bromide, iodide, sulfate, phosphate, oxalate, ethylene glycol, glyoxal, acetate, glycolate, glyoxalate, malonate, maleate, fumarate, and succinate. The V(IV) was separated from the V(III) by elution from cation exchange resin columns with 2 $\underline{M}$ $HClO_4$. Each of the ligands catalyzed the exchange except chloride ($\leq$ 3.8 $\underline{M}$), bromide ($\leq$ 1 $\underline{M}$), iodide ($\leq$ 1 $\underline{M}$), ethylene glycol, and glyoxal. In perchloric acid, the exchange rate increased with increasing ionic strength in accord with the extended form of the Brönsted−Bjerrum equation, and the rate decreased twofold when heavy water was substituted for ordinary water. When the reaction mixtures contained sulfuric acid, however, the deuterium dependence vanished. Rate laws are given for the V(III)−V(IV) exchange in the presence of hydrofluoric, sulfuric, or oxalic acid. In addition to the rate laws for these three systems, overall activation energies and entropies have been determined and reaction mechanisms are proposed. The rate of exchange of radioactive ^{44}Ti between Ti(III) and Ti(IV) in 1 $\underline{M}$ $HClO_4$, 1 $\underline{M}$ HCl, and 11 $\underline{M}$ HCl has been investigated, and in all cases, the exchange was found to be too rapid to be measured by the isotope labeling technique. Although the exchange runs were conducted at 0°C with [Ti(III)] and [Ti(IV)] each less than 0.020 $\underline{M}$, four different separation methods (anion- and cation exchange resin columns, extraction of Ti(III) from 4 $\underline{M}$ thiocyanate solutions and selective precipitation of Ti(IV) with phenylarsonic acid) indicated complete exchange at separation times as early as 30 sec. If the apparent rapid exchange is not separation-induced, second-order rate constants at 0°C greater than 0.35 $\underline{M}^{-1}$ sec^{-1} in 1 $\underline{M}$ $HClO_4$ and 4.8 $\underline{M}^{-1}$ sec^{-1} in 1 $\underline{M}$ HCl are indicated. A Ti(III,IV) binuclear complex in sulfuric acid has been studied at 22°C by spectrophotometric methods. In 5 $\underline{M}$ H_2SO_4 a single broad absorption maximum occurred at 475 mμ. The complex did not appear to form in 1 $\underline{M}$ or in concentrated (18 $\underline{M}$) H_2SO_4, but its absorbance increased with increasing H_2SO_4 concentration in the range 2 to 7.5 $\underline{M}$. The complex contained Ti(III) and Ti(IV) in a 1 : 1 ratio and ϵ_c K_c = 2600, where ϵ_c and K_c are its molar extinction coefficient and formation constant, respectively. (P.C.H.)

26220 (NIJS-R-551) HYDRAZINIUM (+2) HEXAFLUOROMETALATES(IV) AND -(V). Frlec, B. (Nuklearni Institut Jozef Stefan, Ljubljana (Yugoslavia)). Oct. 1968. 8p. (CONF-680836-1). Dep.

From 2nd European Symposium on Fluorine Chemistry, Goettingen, Germany.

Metal hexafluorides react with hydrazinium (+2) fluoride in hydrogen fluoride at room temperature yielding complex fluorides of the type $N_2H_6(MF_6)_2$ and $N_2H_6MF_6$, where M = Mo, Tc, Re, or Os, depending on which reactant is used in excess. No reaction occurs with tungsten hexafluoride, whereas uranium hexafluoride forms, at room temperature, bishexafluorouranate(V) only and hydrazinium (+2) heptafluorouranate(V) if the reaction is carried out at 0°C. Vanadium pentafluoride reacts over an unstable intermediate to eventually form vanadium tetrafluoride only. The $N_2H_6MF_6$(M = Mo, Tc, Re) complex are of bcc symmetry with

a_0 = 10.55, 10.48, and 10.49 Å, respectively. The other compounds are of lower symmetry. The end products of the thermal decompositions of these materials are the metals for transition metal complexes and UF_4 for uranium complexes. For the tetravalent transition metal compounds, reduction is quantitative, while for the pentavalent compounds only partial recovery of the metals was observed because of the volatilization of unknown intermediate products. (auth)

26221 (RFP-Trans-54) BALANCE BETWEEN METALLIC PLUTONIUM AND ITS IONS. STUDY OF THE BALANCE BETWEEN METALLIC PLUTONIUM AND ITS IONS IN CHLORIDE EXTRACTS. Silin, V. I.; Skiba, O. V.; Smirnov, M. V.; Yakovlev, G. I.; Prikhodko, E. A. Translated from At. Energ. (USSR), 25: 26-9(July 1968). 10p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 22: 42669. (auth)

26222 (UCRL-Trans-10343) HEPTAVALENT NEPTUNIUM AND PLUTONIUM. Mefod'eva, M. P. Translated by A. M. A. Mincer for Univ. of California Lawrence Radiation Lab., Livermore, from Priroda, No. 10, 70-2(1968). 9p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 24185. (TSS)

26223 (USC-113-P-21-1) ESR STUDIES OF FREE RADICALS IN RELATION TO BIOLOGICAL EFFECTS OF RADIATION. Progress Report, March 1, 1969. Wolf, Walter (University of Southern California, Los Angeles). Contract AT(11-1)-113. 12p. Dep. CFSTI.

The ESR characteristics of thiyl and related free radicals were studied in order to achieve a better understanding of the role of mercapto containing compounds, both in radiation damage and radiation protection processes. The identification of the signal, arising at g = 2.0106 ± 0.0002 as the RS·, aliphatic thiyl free radical in solution was verified and definitely assigned. ESR signals arising from over 30 thiols were obtained and tabulated, giving a clearer picture of some of the properties of the free radicals thus generated. The properties of some of the other free radical species generated in our system were studied, and kinetic measurements of the reaction were initiated. For the thiyl free radical of cysteine, the DRS·/dt = 4.0 ± 0.9 and –dRS·/dt = 9.1 ± 1.3. Both appearance and disappearance rates obeyed 1st order kinetics. Some of the conditions under which such data were obtained were evaluated. Exploratory studies were initiated using other oxidizing systems, such as metallic chelates, to allow for a thiyl free radical production at physiological pH values. Exploratory studies on the oxidation of thiols in tissues were also begun. (auth)

26224 BROENSTED CATALYSIS OF THE FADING REACTION OF FLASH-PRODUCED TRANSIENTS FROM 2,6-DINITROTOLUENE. Langmuir, Margaret E.; Dogliotti, Libera; Black, Edward D.; Wettermark, G. (Pioneering Research Lab., Natick, Mass.). J. Amer. Chem. Soc., 91: 2204-7(Apr. 23, 1969).

2,6-Dinitrobenzyl anion, λ_{max} 500 mμ, was produced by flash photolysis of 2,6-dinitrotoluene. A study of the catalysis of the reaction, 2,6-dinitrobenzyl anion + HA → 2,6-dinitrotoluene, with acids whose pK's vary from −1.75 to 16.75 has shown that the Brønsted α varies from 0 to 1 as the pK of the donor is increased. The limiting rate of proton transfer in this system (where $\alpha = 0$) is around 10^5 l. $mole^{-1}$ sec^{-1} at 30°C, far below diffusion control. Other factors such as H bonding between anion and donor acid and charge delocalization in the anion must be responsible for the relatively slow proton transfer to carbon. The Arrhenius activation energy for protonation of the anion by H_2O is 11.5 kcal $mole^{-1}$. The transient produced by flashing acid solutions had a λ_{max} of 410 mμ and is the aci form of 2,6-dinitrotoluene. Its pK_a was determined to be 1.8. The direct tautomerizm of aci to nitro form has a rate of 2×10^3 sec^{-1} at 30° and an Arrhenius activation energy of 10.1 kcal $mole^{-1}$. Data are included for the reaction of 2,6-dinitrotoluene anion with D_2O. (auth)

26225 RELATIVE INTENSITY CALCULATIONS FOR CARBON DIOXIDE. IV. CALCULATIONS OF THE PARTITION FUNCTION FOR ISOTOPES OF CO_2. Gray, L. D.; Young, A. T. (Jet Propulsion Lab., Pasadena, Calif.). J. Quant. Spectrosc. Radiative Transfer, 9: 569-89(May 1969).

Internal and vibrational partition functions are tabulated for $^{12}C^{16}O_2$, $^{13}C^{16}O_2$, $^{12}C^{16}O^{18}O$, $^{12}C^{16}O^{17}O$ and $^{13}C^{16}O^{18}O$ for the temperature range 180°–300°K at 10°K intervals. Rotational partition functions are also computed for the five lowest vibrational states of these isotopic forms. For the $^{12}C^{16}O_2$ form the partition functions were recomputed from 300° to 1230°K with greater accuracy and supersede the tabulation given in Part I. (auth) (UK)

26226 ATTAPULGUS CLAY-CATALYZED THERMAL DECOMPOSITION OF TERPHENYLS. Juppe, G.; Rau, H. (EURATOM, Ispra, Italy). J. Appl. Chem. (London), 19: 120-4 (Apr. 1969).

The kinetics of the pyrolysis of pure o-, m- and p-terphenyl and of material mixed with Attapulgus clay were studied. Ten to 12 times more o-, m- and p-terphenyl was decomposed in the clay-catalysed experiments and a strong isomerization of o- into m- and p-, and m- into p-terphenyl appeared. Twice as much benzene and biphenyl was formed in the runs to which clay was added. Similar differences were obtained for the quaterphenyl, triphenyl and triphenylbenzene formations. From the catalysed experiments 50 times as much total gas was found, consisting of 41% hydrogen, 19% methane, 7% ethane, 2% propane, 1.5% n-pentane, 3.8% isopentane, 2.5% ethylene, 0.4% acetylene, 0.9% propene and 32% butenes. The uncatalyzed runs yielded 82% hydrogen, 4% methane, 1% ethane, 0.4% propane, 0.2% n-pentane, 0.3% isopentane, 10% ethylene, 2.8% acetylene, 1.2% propene and 2% butenes. It is suggested that the thermal decomposition of pure terphenyls follows a radical mechanism while the clay-catalyzed pyrolysis follows a carbonium ion mechanism. The studies were conducted in connection with a suggestion to use this clay in the purification of organic reactor coolants. (auth) (UK)

26227 KINETIC ANALYSIS OF THE BROMINATION OF ACETONE IN AN ACIDIC MEDIUM: SOLVENT ISOTOPE EFFECT ON THE RATE OF ENOL KETONIZATION. Dubois, J. E.; Toullec, J. (CNRS, Paris). J. Chem. Soc., D, No. 9, 478-9(May 7, 1969).

The solvent isotope effect on the ketonization of acetone enol demonstrated the similarity of this reaction and the hydrolysis of enol ethers. (auth) (UK)

26228 ABSORPTION SPECTRA OF THE HYDROXO COMPLEXES OF URANIUM(IV) ION IN SOLUTION. Baran, V.; Tympl, M. (Inst. of Nuclear Research, Prague). Collect. Czech. Chem. Commun., 34: 756-66(Mar. 1969).

The absorption spectra of the hydroxo complexes of uranium(IV) were measured in water solution by means of differential spectroscopy. From the spectroscopic point of view the ionic (lower) hydroxo complexes of uranium(IV) behave as a single particle. Hypochromic and hypsochromic changes in their spectra were observed when compared with the spectrum of the free U^{4+} ion. The possible arrangement of these complexes is discussed. Higher hydroxo complexes possess colloidal properties resulting in an unresolved absorption which increases progressively with decreasing wavelengths. (auth)

26229 SPECTROPHOTOMETRIC STUDY OF THE URANYL CHELATE OF 2-(1,8-DIHYDROXY-3,6-DISULFO-2-NAPHTHYLAZO)-PHENOXYACETIC ACID. Shimoishi, Yasuaki (Okayama Univ., Japan). Bull. Chem. Soc. Jap., 42: 690-3(Mar. 1969).

2-(1,8-Dihydroxy-3,6-disulfo-2-naphthylazo)phenoxyacetic acid reacts with the uranyl ion in an acidic medium to form a violet chelate. The composition of the chelate is 1 : 1 in the molar ratio. The apparent stability constants over the pH range from 3.4 to 5.2 and the formation constant of the chelate, are estimated spectrophotometrically at 25°C and an ionic strength of 0.1 by the use of KNO_3. The value of the formation constant was calculated as 1.25×10^{10} from the apparent stability constants. (auth)

26230 WOLFF REARRANGEMENT. V. KINETIC ISOTOPE EFFECT OF α-DIAZOACETOPHENONE. Yukawa, Yasuhide; Ibata, Toshikazu (Osaka Univ.). Bull. Chem. Soc. Jap., 42: 802-5(Mar. 1969).

Kinetic isotope effect of the Wolff rearrangement of carbonyl-^{14}C and phenyl-1-^{14}C labeled α-diazoacetophenone was measured in t-butyl alcohol at 30°C, using a solution of silver benzoate in triethylamine as a catalyst. No apparent kinetic isotope effect was observed in both cases within experimental error. These results suggest that the elimination of nitrogen and the migration of phenyl group proceed in two steps in the rate-determining step. (auth)

26231 CHEMISTRY OF PROTACTINIUM. II. SOLID COMPOUNDS OF TETRA- AND PENTAVALENT PROTACTINIUM. Muxart, R.; Guillaumont, R.; Bouissieres, G. (Institut de Physique Nucleaire, Orsay, France). Actinides Rev., 1: 223-74 (Mar. 1969). (In French).

The preparation and properties of various bromine, chlorine, fluorine, iodine, and oxygen compounds of tetra- or pentavalent protactinium are described. Information on metallic protactinium, as well as sulfur, selenium, nitrogen, carbon, hydrogen, and organic compounds of protactinium is also included. (91 references). (J.G.B.)

26232 INFRARED SPECTRA OF ACYLUREAS AND NN'-DEUTERATED ACYLUREAS. Uno, Toyozo; Machida, Katsunosuke; Hanai, Kazuhiko; Saito, Yutaka (Kyoto Univ.). Bull. Chem. Soc. Jap., 42: 619-24(Mar. 1969).

The ir spectra of seven monoacylureas and their NN′-deuterated compounds were measured in the region between 3600 and 450 cm^{-1}. A number of characteristic absorption bands of the $-CONHCONH_2$ and $-CONDCOND_2$ groups were found and assigned by referring to the ir spectra of related compounds and the isotopic frequency shifts. Partial deuteration by mixtures of water and heavy water were made to distinguish the absorptions due to the NH and NH_2 groups from each other. The features of ir spectra of monoacylureas can be explained by regarding them as composite spectra of aliphatic imides and urea. From the effect of the alkyl frame-work vibrations for the imide III frequency, it is suggested that the RCONH- group of monoacylureas takes the *trans* conformation. (auth)

26233 MICROWAVE STUDY OF THE ADSORBED SPECIES IN THE DEUTERIUM-EXCHANGE REACTIONS OF PROPYLENE WITH REFERENCE TO ITS CATALYTIC HYDROGENATION. Ueda, Tomiko (Inst. of Physical and Chemical Research, Tokyo); Hara, Jizaemon; Hirota, Kozo; Teratani, Shousuke; Yoshida, Noritetsu. Z. Phys. Chem. (Frankfurt), 64: No. 1-4, 64-70 (Mar. 1969).

Deuterium-exchanged positions of the monodeuteropropylene produced in the exchange reactions relating to propylene were investigated on Cu and Rh by means of the microwave spectroscopy, similarly as done on Ni, Pd, and Pt previously. Results show that the adsorbed species of propylene are drastically different according to metals, and double-bond migration occurs during the adsorption and desorption processes of propylene. (auth)

26234 HYDROGEN ISOTOPE EQUILIBRATION ON GADOLINIUM FILMS. Eley, D. D.; Norton, P. R. (Nottingham Univ., Eng.). Z. Phys. Chem. (Frankfurt), 64: No. 1-4, 145-53(Mar. 1969).

Films of gadolinium evaporated at 10^{-10} torr were examined as catalysts for the pH_2, oD_2 and $H_2 + D_2$ reactions, at pressures Ca 1 torr and temperatures 77 to 450°K. Hydrogen absorption occurs and lowers the catalyst activity, but reproducible results were obtained on the films stabilized at an overall composition of about GdH, which were probably a mixture of Gd and defect GdH_2 phases. At higher temperatures, viz. 273°K, all three reactions, which have a similar rate to hydrogen absorption, probably go through the simple dissociation-recombination of H_2, the Bonhoeffer-Farkas mechanism. At low temperatures, 77°K, this may change over to a molecule-adsorbed atom exchange mechanism for $H_2 + D_2$, but the pH_2, oD_2 isomerization go at the same rate ($1000 \times H_2 + D_2$ rate) by a paramagnetic mechanism invoked by the unpaired f electrons, atomic moment 7.55 BM. A comparison with calculated rates for the three variants a) collision, b) vibration over a strongly adsorbing site, c) surface translation, suggests b) as most likely. The conversion rate for pH_2 at 77°K is less than that of oD_2, which is anomalous. A similar result may hold for Ni films, in contrast with Ni wires where c) gives a better fit. The failure to observe a magnetocatalytic effect at the Curie point of Gd, 293°K, may be due to the effect of absorbed (and perhaps adsorbed) hydrogen in bonding the conduction (ds^2) electrons responsible for the ferromagnetic coupling of moments in this metal. (auth)

26235 ISOTOPE EFFECTS IN ACETYLACETONE AND LEWIS ACID-BASE ADDUCTS OF β-DIKETONES. PARTS ONE AND TWO. Thompson, David Wallace. Evanston, Ill., Northwestern Univ., 1968. 160p.
Thesis.

Isotope effects in acetylacetone were investigated by proton magnetic resonance, infrared spectroscopy, and ultraviolet spectroscopy. Partial substitution of deuterium at the terminal methyl groups and at the 3-position in the keto tautomer shifted the proton resonance peaks up-field. The change in the keto-enol tautomeric equilibrium resulting from deuterium substitution at the methylene carbon was measured at various temperatures. The enthalpy change for enolization of the protium-containing compound is more negative than for the deuterium-containing compound. Adducts of Group IV tetrahalides with acetylacetone, 3-methylacetylacetone, and 3,3-dimethylacetylacetone were prepared and characterized. Analytical, nuclear magnetic resonance, and infrared data are consistent with the compounds being simple 1 : 1, nonionic adducts. (Diss. Abstr.)

26236 ON THE MAGNETIC AND SPECTROSCOPIC PROPERTIES OF URANIUM OXIDE-FLUORIDES AND THEIR STRUCTURAL RELATIONSHIPS TO THE OXIDES OF THE URANIUM. Kemmler-Sack, S. (Univ., Tuebingen, Ger.). Z. Anorg. Allg. Chem., 364: 88-99(Jan. 1969). (In German).

The magnetic and optical properties of fifteen UO−F phases with U(V) and U(VI), respectively, are described. There are strong structural relationships between these phases and the structures of some uranium oxides in the range of U_3O_8 to UO_3. The oxides and the oxide fluorides contain O−U−O chains (ligand field symmetry $D_{\infty h}$). Twenty-six references are cited. (JPRS)

26237 CRYOSCOPIC STUDIES ON THE FUSED NaCl, KCl, AND MIXTURE OF BOTH SALTS CONTAINING EACH OF $BeCl_2$, $ThCl_4$, AND UCl_4. Oyamada, Ryozo (National Research Inst. for Metals, Tokyo); Yoshida, Susumu. Denki Kagaku, 36: 187-91(1968).

Experiments were carried out on the freezing point depressions of molten NaCl, KCl, and a mixture of NaCl−KCl (molar ratio = 1 : 1) caused by the addition of $BeCl_2$, $ThCl_4$, and UCl_4 to study the fundamental properties of solvents. Results of experiments indicated negative deviation from an ideal solution behavior. Thermodynamic quantity, α-function were calculated to discuss the nature of solvents. The solutions with $BeCl_2$ can be regarded as semi-regular solutions within the concentration range of present experiments. The excess free energy of the solutions is larger in the order of NaCl−KCl < NaCl < KCl in the cases of the salts, $BeCl_2$, $ThCl_4$, and UCl_4. (NSA of Japan)

26238 PROCESS FOR THE BITHERMAL ISOTOPIC ENRICHMENT OF AMMONIA AND HYDROGEN WITH DEUTERIUM AND APPARATUS THEREFOR. Poole, Keith Roderick (to United Kingdom Atomic Energy Authority). U. S. Patent 3,437,442. Apr. 8, 1969. Priority date Mar. 10, 1965, Great Britain.

A process and apparatus for the bithermal isotopic enrichment of NH_3 and H_2 with D is characterized by subjecting NH_3 condensed from the H_2 on cooling to a cracking process to yield a mixture of N_2 and H_2 that is isotopically exchanged with NH_3 in a cold exchange tower. (Offic. Gaz.)

26239 EXPERIMENTAL STUDY OF THE LIQUID-VAPOR EQUILIBRIUM IN THE BINARY SYSTEM URANIUM HEXAFLUORIDE-CHLORINE TRIFLUORIDE AT A PRESSURE OF 2600 Torr. Aubert, J.; Carles, M.; Bethuel, L. Chim. Ind., Genie Chim., 98: 661-8(Sept. 1967).

The liquid-vapor equilibrium in the binary system UF_6-ClF_3 at a constant pressure, as investigated by McGill and Barber up to 2280 mm Hg, was re-examined at 2600 mm Hg in Monel equipment. Homogeneity of the liquid was obtained by magnetic stirring and also by returning the gas through the liquid by means of electromagnetic pump. Molar composition determination of gaseous and liquid phases was made by means of an ir spectrophotometer and Monel cell provided with silver chloride windows. A plot of the equilibrium diagram showed complete miscibility over the whole range of concentrations, the temperatures varying from 44.5 to 92.5°C. Activity coefficients varied from 1 to 3.4 for UF_6 and from 1 to 1.7 for ClF_3. Vapor pressures of ClF_3 could be represented in the range from 20 to 60°C by the equation: $\log P\ (mm\ Hg) = 7.03155 - 1434.71/T°K$. (BBB)

26240 AN INVESTIGATION INTO THE INTERACTION BETWEEN IODINE AND BACTERIA. Brandrick, Angela M. (Univ. of Manchester, Eng.); Newton, J. M.; Henderson, G.; Vickers, J. A. J. Appl. Bacteriol., 30: 484-7(Dec. 1967).

The interaction between ^{131}I in aqueous solutions and washed suspensions of *Escherichia coli* and *Staphylococcus aureus* was investigated. The conditions of the experiments were such that the bacteria were killed and no free radioiodine remained. Carbon tetrachloride extracts of the supernatant fluid never contained >10% of the total ^{131}I. This indicates that the radioiodine in the supernatant fluid was predominantly nonelemental in nature, as elemental radioiodine would have been extracted by the carbon tetrachloride. The uv spectra had the characteristic iodide peak at 226 mμ not present in the original elemental radioiodine solution. The fact that most of the original elemental iodine was converted to iodine indicates an oxidation-reduction reaction, whereby iodine was reduced to an equivalent amount of iodide and susceptible groups in or on the bacterial cell were oxidized. The existence of radioiodine on the cells indicates that some iodine reacted by addition or substitution with the cell constituents. (BBB)

26241 NEUTRON RADIATION SORBERS. Strand, Norman S. (to Dow Chemical Co.). U. S. Patent 3,423,375. Jan. 21, 1969. Filed Nov. 29, 1963.

A method is described for producing a neutron-absorbing material consisting of a polyethylene sulfonate of one of the following metals: Li, Co, Rh, Ag, Cd, In, Nd, Sa, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, Hf, Re, Ir, Au, and Hg and having a thermal neutron cross section greater than 33.6 ± 1 barn. The material is prepared by reacting polyethylene sulfonates in acid or alkali metal salt form with a water soluble salt of one or more of the listed metals in an amount at least sufficient to produce the desired salt, mixing the reactants in aqueous medium, and washing with water to remove by-product salts. The material is then extruded into layers or molded into blocks, and the thermal stability of the products is increased by a surface crosslinking treatment consisting of immersing the layer or block in acid, exchanging metal ions on or near the surface for protons, and then heating for an hour or more at 50 to 100°C. (B.L.M.)

26242 CALCULATION OF THE CENTRIFUGAL DISTORTION CONSTANTS AND INERTIA DEFECTS OF H_2S, D_2S, H_2Se, AND D_2Se, INTRODUCING THE INFLUENCE OF ANHARMONICITY. **Gamo, Itaru (Univ. of Waseda, Tokyo. Univ. of Maryland, College Park). J. Mol. Spectrosc., 30: 216-31(May 1969).**

Several of the harmonic frequencies of these molecules were empirically determined to two decimal places in cm^{-1}. These, together with the rest previously estimated to the same degree of accuracy, were used to evaluate quadratic potential constants in the most general force field. In relation to this, a comparison is given between accuracies of some prevailing methods of estimating harmonic frequencies for the bent XH_2 and XD_2 molecules. It was confirmed that the Dennison's isotopic rule, which states that the anharmonic correction is proportional to the harmonic frequency, supplies a simple and efficient method when combined with the Wilson's splitting of high frequencies from low for vibration calculation. This method increases its accuracy rapidly with increasing mass of the central atom. The calculated harmonic frequencies and potential constants enabled evaluation of the centrifugal distortion constants and inertia defects. A major part of the hitherto involved uncertainties, which are due to partial or complete neglect of anharmonicities, seems to have been removed. The obtained centrifugal stretching constants in the ground state are presented. The calculated inertia defects are in good agreement with experiments. (auth)

26243 ANALYSIS OF THE 1400 A ELECTRONIC TRANSITION OF THE ETHANE MOLECULE. **Pearson, E. F.; Innes, K. K. (Vanderbilt Univ., Nashville). J. Mol. Spectrosc., 30: 232-40(May 1969).**

Ethane is the only alkane which exhibits structure in its molecular electronic absorption spectrum. High resolution photographs reveal that this is diffuse vibrational structure in the case of C_2H_6. However, the 0−0 band of C_2D_6, near 1406 Å, exhibits a distinctive rotational contour. Computer simulation of the contour shows that the transition moment for the 0−0 band lies perpendicular to the carbon−carbon bond: The electronic transition is $^1E_u - ^1A_{1g}$, in agreement with majority theory. Vibrational analysis shows that the transition effects a large reduction in the C−H stretching frequency (a_{1g}), consistent with a 731 cm^{-1} shift of the origin band toward higher frequencies on deuterium substitution, and with promotion of an electron out of the C−H bond. Electronic angular momentum is detected in the excited state. Finally, it is deduced that the lifetime of the excited state of C_2D_6 is about 10^{-11} seconds. (auth)

26244 ANHARMONIC POTENTIAL CONSTANTS FOR CH STRETCHING IN THE HCO RADICAL. **Dixon, R. N. (Sheffield Univ., Eng.). J. Mol. Spectrosc., 30: 248-52(May 1969).**

A close fit to the fundamental vibration frequencies of HCO and its isotopic modifications were obtained by allowing for the anharmonicity of the CH bond using a Morse potential function. The apparent dissociation energy for this potential, $D_{H-CO} \sim 1.7$ eV, indicates strong configuration interaction between structures corresponding to the combination of ground state and excited state dissociation products. (auth)

26245 THE FORCE FIELD AND NORMAL COORDINATES OF CYCLOPROPANE-H_6 AND -D_6. **Duncan, J. L. (Univ. of Aberdeen, Scotland); Burns, G. R. J. Mol. Spectrosc., 30: 253-65(May 1969).**

Force constants and normal coordinates are reported for the cyclopropane molecule. Recently determined data on all the fundamental vibration frequencies and E′ Coriolis zeta constants of cyclopropane-H_6 and -D_6, as well as zeta constants for the E″ species of C_3H_6, were used to refine to the A_1' and E′ species force constants with one constraint, and to the A_2'' and E″ species force constants with two constraints. In the A_1' and E″ species, predictions of the hybrid orbital model are fulfilled; in the A_2'' and E″ species, there are insufficient data to test the model. The results were used to predict the fundamentals of cyclopropane-D_5 (present as isotopic impurity in our sample of C_3D_6), to compute the observed intensity perturbation arising from Coriolis interaction between the ν_{10} and ν_{11} fundamental vibrations in cyclopropane-D_6; and to calculate centrifugal distortion constants for C_3H_6. The good agreement with experimental observations in each case acts as a check on the accuracy of our derived force field. The choice of valence symmetry coordinates, either avoiding or including the ring angle redundancy, is briefly discussed. (auth)

26246 SOME TERNARY URANIUM CHALCOGENIDES. **Klein Haneveld, A. J.; Jellinek, F. (Univ. of Groningen, Netherlands). J. Less-Common Metals, 18: 123-9(June 1969).**

The synthesis and crystal structures of the ternary uranium compounds UYX, where Y = Si, Ge, Sn, Sb, and X = S, Se, Te, are reported. USiS, UGeS, USnTe, USbS, USbTe, and also UTe_{2-x} are isotypic with ZrSiS which has a distorted PbFCl-type structure. USiSe, UGeSe, and UGeTe have structures of a new type, closely related to that of ZrSiS. The compounds USiTe, USnS, and USnSe could not be prepared. The instability of these compounds and the occurrence of ZrSiS and UGeTe-type compounds are discussed. (auth)

26247 A STRONG CORIOLIS PERTURBATION IN THE INFRARED SPECTRUM OF TRANS-d_2 ETHYLENE. **di Lauro, C. (Univ., Naples). J. Mol. Spectrosc., 30: 266-74(May 1969).**

The ν_7 C-type perpendicular band in the infrared spectrum of trans-$C_2H_2D_2$ was analyzed, the anomalous rotational structure being explained in terms of Coriolis resonance with ν_{10}. Earlier assignments of the Q-branches were corrected. The vibrational frequency $\nu_7^0 = 724.5 \pm 0.5$ cm^{-1} was determined with the aid of a graphical procedure. No definitive results were established for ν_{10}. (auth)

26248 PROTON NUCLEAR MAGNETIC RESONANCE STUDIES OF THE 8-QUINOLINOL COMPLEXES OF THORIUM(IV) AND URANIUM(VI). **Baker, Blair C.; Sawyer, Donald T. (Univ. of California, Riverside). Inorg. Chem., 8: 1160-4(May 1969).**

The proton NMR spectra of the 8-quinolinol (oxine, HOx) complexes of thorium(IV) and uranium(VI) in DMSO solutions were recorded and analyzed. The data establish that the "solvated" complexes of thorium and uranium, $ThOx_4$, HOx, and $UO_2Ox_2 \cdot HOx$, exist only in the solid phase and dissociate to $ThOx_4$ and UO_2Ox_2 in solution. The oxines in the latter complexes are equivalent on the basis of the NMR data. Studies of the $UO_2Ox_3^-$ complex also confirm that the three oxines are equivalent. Drying studies and differential thermograms of the various solvated oxine complexes of thorium and uranium were used to characterize the solid species. The red form of $UO_2Ox_2 \cdot HOx$ has a much greater thermal stability than the orange form and can be dried to constant weight at 150°C. The maroon hydrate, $UO_2Ox_2 \cdot 3H_2O$, also is stable up to 150°C. (auth)

26249 SYNTHESIS OF DEUTERIO-1-AMPHETAMINE, d_1 SULFATE. Foreman, Ronald L.; Siegel, Frederick P.; Mrtek, Robert G. (Univ. of Illinois, Urbana). J. Pharm. Sci., 58: 189-92(Feb. 1969).

In order to investigate the isotope effect on the enzymatic deamination of amphetamine, deuterio-l-amphetamine, d_1 sulfate was synthesized by the selective reduction of phenyl-2-propanone oxime with lithium aluminum deuteride, followed by resolution of the racemic product. The yield of racemic amphetamine was 46% when approximately equimolar quantities of the oxime and $LiAlD_4$ were employed. The identity of the deuterated amphetamine base was confirmed by determination of the physical properties of the racemic mixture. From NMR data, deuterium was found exclusively in the methine hydrogen position at a purity of greater than 99 atom %. The optical isomers of deuterioamphetamine were resolved through repeated fractional crystallization of the d-amphetamine-d-bitartrate and l-amphetamine-l-bitartrate diastereomers. The isomers were found to possess 97 to 99% optical purity, based on values for pure isomers of protioamphetamine. In vitro metabolism studies indicate that a significant deuterium isotope effect operates in the oxidative deamination of deuterio-l-amphetamine. Under specified conditions, the ratios of apparent rate constants (k_H/k_D) based on initial velocities, yield a value of 2.0 ± 0.3. (auth)

26250 METHOD FOR DEUTERATING ORGANIC COMPOUNDS. **Dinh-Nguyen, N.; Stenhagen, E. A. (to Incentive Research Development AB). Canadian Patent 806,242. Feb. 11, 1969. Priority date Feb. 1, 1965, Sweden.**

With heavy water as the deuterium source, organic compounds of high molecular weight may have their H atoms substituted by D. The improvement consists of adding deuterium peroxide (D_2O_2) as a promoter in the presence of an alkali (NaOD) and a Pt metal catalyst. The reaction is carried out in a closed vessel with vigorous shaking at an elevated temperature. (F.S.A.)

26251 METALLO-ORGANIC COMPOUNDS CONTAINING METAL–NITROGEN BONDS. PART VI. INFRARED AND NUCLEAR MAGNETIC RESONANCE OF DIALKYLAMIDO-DERIVATIVES OF TITANIUM, VANADIUM, ZIRCONIUM, NIOBIUM, HAFNIUM, TANTALUM, AND THORIUM. **Bradley, D. C.; Gitlitz, M. H. (Univ. of Western Ontario, London, Can.). J. Chem. Soc., A, No. 6, 980-4(1969).**

Infrared and NMR spectra were measured on solutions of a number of dialkylamido-compounds $M(NR_2)_x$ of titanium, vanadium, zirconium, niobium, hafnium, tantalum, and thorium, on the alkylimido-trisdialkylamidotantalums $RN = Ta(NR_2)_3$. Assignments of characteristic bands were made and the metal–nitrogen stretching frequencies discussed in terms of a significant contribution of nitrogen → metal p_π-d_π bonding. Variable temperature NMR studies on $Zr(NMe_2)_4$ confirmed the presence of polymeric species in solution. (auth) (UK)

26252 PROTON MAGNETIC RESONANCE SPECTRA OF SOME ACTINIDE β-DIKETONE COMPLEXES. Wiedenheft, C. (Mound Lab., Miamisburg, Ohio). Contract AT(33-1)-Gen-53. Inorg. Chem., 8: 1174-9(May 1969).

The NMR spectra of several actinide β-diketone complexes were obtained in chloroform solution. As opposed to the solid-state structure, the structure in solution of the thorium and uranium dibenzoylmethane complexes is an undistorted square antiprism. Using the ligand 1-phenyl-1,3-hexanedione, the isotropic shifts of the uranium complex were separated into a pseudocontact shift and a contact shift. The contact shift was related to spin delocalization via the π orbitals indicating the interaction of the f orbitals with these β-diketone ligands. The spin delocalization is a small effect being only about one-fifth of that observed for the transition metal ions. (auth)

26253 METAL COMPLEXES OF "SQUARIC ACID" (DIKETOCYCLOBUTENEDIOL) IN AQUEOUS SOLUTION. Tedesco, P. H.; Walton, H. F. (Univ. of Colorado, Boulder). Inorg. Chem., 8: 932-7(Apr. 1969).

Formation constants of complexes of diketocyclobutenediol (squaric acid) with several metal ions were measured in aqueous solution at 25°C and ionic strength 0.5 and found to be as follows: Fe(III), 41,000; U(VI), 1200; Al(III), 680; Cu(II), 160; Mn(II); 32; Co(II), 42; Ni(II), 30. A few measurements were made at other temperatures and ionic strengths. Spectrophotometric, polarographic, potentiometric, and paper-chromatographic techniques were used. In every case, 1 : 1 complexes predominated over a wide concentration range. The complexes of Fe, U, and Cu are strongly colored; yellow and brown solutions were also observed with Ti(IV) and Ti(III). Sparingly soluble solid yellow complexes of U(VI) and Ti(IV) were prepared and analyzed, and the solubility of copper(II) squarate was redetermined. K_2 for squaric acid was found to be 1.3×10^{-3} at 25°C and ionic strength 0.5. The complexes are of special interest because of the simple aromatic character of the ligand ion. (auth)

26254 TELLURIUM ISOTOPE FRACTIONATION STUDY. Smithers, R. M.; Krouse, H. R. (Univ. of Alberta, Edmonton). Can. J. Chem., 46: 583-91(Feb. 15, 1968).

"Normal vibration equations" were solved to yield vibrational frequencies for isotopic compounds of tellurium. These frequencies were used to evaluate "partition function ratios" for ^{122}Te- and ^{130}Te–containing compounds. Theoretical "isotopic equilibrium exchange constants" and estimates of "kinetic isotope effects" were derived from these ratios. The results suggest that the ^{122}Te/^{130}Te abundance may be altered significantly in laboratory reactions and terrestrial processes. Preliminary experiments have realized kinetic isotope effects of 0.7 and 0.6% in inorganic and microbiological reductions respectively of tellurite to elemental tellurium. These results are interpreted in terms of the isotope effect in Te–O bond breakage. The maximum variation in the ^{130}Te/^{122}Te abundance ratio of six natural tellurides and two commercial preparations of TeO_3^{2-} was found to be 0.4%. The results are compared with those found in analogous selenium and sulfur isotope investigations. (auth) (CANADA)

26255 SECONDARY KINETIC ISOTOPE EFFECTS IN BIMOLECULAR NUCLEOPHILIC SUBSTITUTIONS. III. DEUTERIUM EFFECTS IN THE BUNTE SALT REACTION OF METHYL HALIDES AND SULFONATES. Jackson, G. E.; Leffek, K. T. (Dalhousie Univ., Halifax, Nova Scotia). Can. J. Chem., 47: 1537-41(May 1, 1969).

Secondary kinetic deuterium isotope effects were measured for the reaction between thiosulfate ion and methyl-d_3 halides and sulfonates in 50% v/v ethanol–water. The results are used to extend the correlation of Seltzer of k_H/k_D with the difference between the polarizabilities of the attacking nucleophile and the leaving group. Dissociation constants for the $[NaS_2O_3]^-$ ion were determined by conductivity measurements for the reaction conditions and used to calculate the concentration of free thiosulfate ions present in the reaction mixture. The activation parameters ΔH^* and ΔS^*, based on second order rate constants calculated with respect to the concentration of thiosulfate ion, are reported. (auth) (CANADA)

26256 PROTON MAGNETIC RESONANCE STUDIES OF PARAMAGNETIC 4f AND 5f SYSTEMS CONTAINING THE CYCLOPENTADIENYL LIGAND. von Ammon, R. (Gesellschaft fuer Kernforschung, Karlsruhe, Ger.); Fischer, R. D.; Laubereau, P. Inorg. Nucl. Chem. Lett., 5: 315-19(Apr. 1969).

Results are described for solutions of the following systems at room temperature: (a) Some adducts of Cp_3LnB (where Cp denotes the cyclopentadienyl ligand, Ln is a trivalent rare earth ion, and B is a neutral Lewis base molecule); (b) three base-free Cp_3Ln complexes, sufficiently soluble in benzone or cyclohexane without an additional ligand B; (c) Yb complexes of the type $(Cp_2YbL)_2$, where L is either Cl or NH_2; (d) a number of actinide complexes of type (a). The results for the Cp-proton shifts of the following systems with three Cp ligands are tabulated and discussed: Pr (III), U(IV), Nd(III), Np(IV), Pu(III), Ho(III), Tm(III), and Yb(III); also for Cp-proton shifts of $(Cp_2YbL)_2$ systems. (UK)

26257 RELATION BETWEEN CATALYTIC PROPERTIES AND STRUCTURE OF METAL FILMS. I. DEUTERIUM EXCHANGE OF METHANE, ETHANE, AND PROPANE OVER NICKEL. Anderson, J. R.; MacDonald, R. J. (Flinders Univ., Adelaide). J. Catal., 13: 345-59(Apr. 1969).

To assess the influence of surface structure on the mode of adsorption of saturated hydrocarbons, deuterium exchange reactions with propane, ethane, and methane were studied over various ultra-high-vacuum-deposited nickel films. Reactions were studied over {111} and {100} surfaces, prepared by nickel evaporation onto mica and sodium chloride, respectively, at elevated substrate temperatures, as well as over sintered and unsintered random polycrystal films. Reactions with propane and ethane gave initial product distributions from which the following conclusions are drawn: (i) at exchange temperatures, it is very unlikely that a monoadsorbed hydrocarbon residue will be retained on {111} or {100} surfaces because of the ready formation of a double bond between the carbon and the metal; (ii) surface sites for the retention of a monoadsorbed hydrocarbon residue are present on low-temperature random polycrystal films, but they are thermally unstable in that they are much reduced by sintering, and are completely absent in {111} or {100} surfaces; (iii) exchange by a process of rapid interconversion between monoadsorbed and α,β-diadsorbed surface species does not occur on {111} or {100} surfaces and, ipso facto, is unlikely on sintered surfaces; (iv) multiple exchange occurs mainly by desorption from extensively dehydrogenated surface residues. It is suggested that the thermally unstable sites suitable for monoadsorption are associated with atomically rough areas of surface, either as high index planes or facets, or a quasi-macroscopic features such as steps and terrace edges. Although the product distributions were sensitive to surface structure, activation energies and frequency factors were not. Methane exchange did not show discrimination with respect to surface structure, and reasons for this are discussed. The possible unreliability of exchange data obtained under conditions of poor surface cleanliness is emphasized. (auth)

26258 OXIDATION OF PROPYLENE BY MEANS OF SnO_2–MoO_3 CATALYSTS. II. HYDROGEN–DEUTERIUM EXCHANGE BETWEEN PROPYLENE AND WATER. Buiten, J. (Staatsmijnen/DSM, Netherlands). J. Catal., 13: 373-84(Apr. 1969).

It was found that in the presence of SnO_2 covered with MoO_3 and at a temperature of 360°C, propylene and D_2O rapidly exchange hydrogen against deuterium. The distribution of the deuterium over the propylene molecules proved to be approximately binomial. One of the hydrogen atoms in the propylene molecule participated only slightly in the exchange; this must have been the atom bonded to the central carbon atom. Infrared absorption measurements revealed that deuterium appears preferably in the methylene group (as was confirmed by a proton magnetic resonance measurement), and for the greater part in the cis position with respect to the methyl group. An explanation of the exchange which accounts for the availability of five hydrogen atoms in the propylene molecule for the exchange while being compatible with the mentioned preference, is represented by a reversible reaction between propylene and acid surface hydroxyl groups yielding surface-bonded isopropyl groups (or isopropoxy groups, if the surface oxygen atoms are considered to be included). These groups also constitute the intermediate species in the oxidation of propylene to acetone and acetic acid. MoO_3 gave a low exchange rate, while SnO_2 proved to hold an intermediate position between MoO_3 and SnO_2/MoO_3. The same applies to the rate of oxidation of propylene. With SnO_2/MoO_3, isopropyl alcohol was very rapidly dehydrated to propylene at 370°C; also during oxidation of propylene over this catalyst, the off-gas showed the low equilibrium concentration of isopropyl alcohol–even at a very high space velocity. In the dehydration of isopropyl alcohol, MoO_3 showed a fairly high activity. The catalytic action of SnO_2 on isopropyl alcohol, however, was directed almost exclusively towards the oxidative dehydrogenation to acetone. This is one of the arguments to be raised against the view that the above-mentioned isopropyl (isopropoxy) group is also an intermediate in the dehydration of isopropyl alcohol. All experiments were done in the presence of air and water vapor. (auth)

26259 CALCULATION OF KINETIC ISOTOPE EFFECTS IN FORMATION OF CARBON DIOXIDE FROM A DIESTER OF

OXALIC ACID. Warkentin, J.; Singleton, D. M. (McMaster Univ., Hamilton, Ont.). Can. J. Chem., 45: 3045-8(Dec. 15, 1967).

Equations for the calculation of isotope effects (k_{12}/k_{13} and k_{16}/k_{18}) in the concerted two-bond thermolysis of oxalates are presented. The equations are developed for material of low isotopic abundance such that the presence of doubly labelled molecules can be ignored. No assumption is made about the distribution of ^{18}O between the carbonyl and ether functions, other than that the distribution is known. The experimental data required are the ratios CO_2^{46}/CO_2^{44}, and CO_2^{45}/CO_2^{44}, corrected for the presence of ^{17}O and ^{14}C in the CO_2 obtained from partial decomposition and in the CO_2 from total decomposition and the fractional extent of reaction. (auth) (CANADA)

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Refer also to abstracts 26313, 26317, 26341, 26464, 27344, 28354, 28459, 28528, and 28561.

26260 (AD-680759) NANOSECOND PULSE RADIOLYSIS OF POLYSTYRENE AND POLY (METHYL METHACRYLATE). Ho, S. K.; Siegel, Seymour (Aerospace Corp., El Segundo, Calif.). Nov. 1968. Contract F04701-68-C-0200. 43p. (TR-0222(4250-20)-1; SAMSO-TR-68-473). CFSTI.

Polystyrene and poly(methyl methacrylate) (PMMA) containing diphenyl and naphthalene as solutes were studied by nanosecond pulse radiolysis. Solute negative ions were detected in PMMA but not in polystyrene. Solute triplet states were formed in times short compared with the lifetimes of the solute excited singlet states, whose presence was observed via their fluorescence. G (triplet) values for 0.2M samples of naphthalene and diphenyl in polystyrene were estimated to be 1.7 and 1.3, respectively. It is also shown that for high concentrations of solute less than 25% of the solute triplet states is derived from ion neutralization inside the spur. No evidence of intersystem crossing from solute excited singlet states was observed. Triplet yields in PMMA were smaller than those in polystyrene by a factor of two or more and were strongly affected by other transient species accumulated in previous irradiations. This latter quenching mechanism appears to involve the precursor, rather than the solute triplet states themselves. Possible modes of solute triplet state formations are discussed, and it was concluded that triplet energy transfer from the solvent is the most probable mechanism. (auth) (USGRDR)

26261 (AERE-M-2135) SOME CHEMICAL METHODS FOR THE SEPARATION OF HIGH PURITY SHORT-LIVED FISSION PRODUCTS. Bullock, R. J.; Large, N. R. (Atomic Energy Research Establishment, Harwell (England)). Mar. 1969. 13p. Dep. CFSTI. UK 2s. 6d.

Standard radiochemical techniques were adapted to give rapid separation of radiochemically pure samples of short-lived isotopes of the following elements: bromine, rubidium, silver, cesium, lanthanum, and praseodymium. Three of the elements considered, silver, lanthanum, and praseodymium, are obtained by milking their precursors, palladium, barium, and cerium. (auth) (UK)

26262 (AERE-Trans-1107) γ-RADIOLYSIS OF LIQUID CARBON MONOXIDE AT −196°C. Buschmann, H. W.; Groth, W. Translated by J. E. Baker (Atomic Energy Research Establishment, Harwell, Eng.), from Z. Naturforsch., 22A: 954-60(1967). 19p. Dep. CFSTI, UK 3s. 0d.

An abstract of this paper, prepared from the original language, appeared as NSA 21: 34294.

26263 (BMwF-FBK-69-2) INVESTIGATION OF INTER- AND INTRAMOLECULAR ENERGY TRANSFER IN ALKANE-BENZENE MIXTURES AND ALKYLBENZENES. Heusinger, H.; Zeman, A.; Hofer, H. (Technische Hochschule, Munich (West Germany). Institut fuer Radiochemie). Jan. 1969. 47p. (In German). Dep.

From investigations of radiolytic hydrogen production and radical formation in alkane-benzene mixtures, n-alkylbenzenes, and isomeric alkylbenzenes conclusions on energy transfer processes can be drawn. A Markov chain approach shows, that energy transfer from the aliphatic component to the phenyl ring for alkane-benzene mixtures is 10 times, for alkylbenzenes 13 times more probable than dissociation of a C−H bond or deactivation of the states involved. These results suggest, that in alkylbenzenes besides intermolecular energy transfer also intramolecular energy transfer takes place. Scavenger experiments give some information on the mechanism. (auth)

26264 (BNL-12519) MIXING EFFECTS IN CHEMICAL REACTORS. II. RADIATION-INDUCED CHAIN REACTIONS IN FLOW SYSTEMS. Felder, R. M.; Hill, F. B. (Brookhaven National Lab., Upton, N. Y.). May 1968. 47p. (CONF-681212-1). Dep. CFSTI.

From 61st Annual American Institute of Chemical Engineers Conference, Los Angeles, Calif.

It has been reported previously that radial mixing or diffusion of reactant in a continuous tubular reactor tends to enhance reactor performance. This was the result of a single-step s^{th}-order reaction ($s \geq 0$), an arbitrary residence time distribution, and an arbitrary dependence of the specific rate constant on position in the reactor. Similar results were obtained for a chain reaction in which radial mixing of radicals and/or reactants may occur. Necessary and sufficient conditions for the existence of a radical mixing effect on reactor performance are derived, and the direction of such an effect is established. Illustrative results are presented for a continuous annular photoreactor in which nonuniform absorption of radiation leads to an inhomogeneous local reaction rate. The influences on reactor performance of the residence time distribution, the spatial reaction rate nonuniformity, and the presence of reactant and radical mixing are demonstrated. (auth)

26265 (CEA-R-3637) ELECTRON PARAMAGNETIC RESONANCE STUDY OF RADICALS FORMED BY RADIOLYSIS AT 77°K OF NITROALKANES AND OF THEIR SOLUTIONS IN ORGANIC GLASSES. CHROMATOGRAPHY ANALYSIS OF RADIOLYSIS PRODUCTS OF NITROMETHANE IN ETHANOL SOLUTION IN A VITREOUS MEDIUM. Rosilio, Charles (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1969. 127p. (In French). Dep.

Thesis. Submitted to Univ., Paris.

Studies were made on the structure and reactivity of the radicals formed by γ irradiation of the nitrogen containing derivatives at 77°K, and on the mechanism of formation and of disappearance of these radicals in the various matrices used. The radicals resulting from the removal of a hydrogen atom in the α position of the NO_2 group, and the radicals resulting from addition reactions on the nitrogen group characterized by an unpaired electron on the nitrogen have been identified, either during the radiolysis of pure nitroalkanes, or during the radiolysis of nitroalkanes in solution in organic glasses at 77°K. A study has been made of the conformation and the movements of radicals in the matrices, and the mechanism of formation of the observed radicals produced generally by the capture by the nitroalkanes of primary radiolysis species. The nitroalkanes in ethanol solution can behave as traps both for electrons and for free radicals. The study of the radiolysis of nitroalkanes in solution in a polar ethanol glass has been completed with chemical analyses on the final radiolysis products; it has been possible to deduce the capture efficiency of trapped electrons and of free radicals by nitroalkanes in ethanol. The radiochemical yields of hydrogen, acetaldehyde, and glycol were measured as a function of the capture agent concentration, for the nitromethane−ethanol system. A mechanism for the disappearance of the observed radicals is proposed. (6 references) (auth)

26266 (COO-1088-33) THE RADIATION CHEMISTRY OF HIGH POLYMERS. Technical Report No. 14, April 1, 1968-April 1, 1969. Dole, Malcolm (Northwestern Univ., Evanston, Ill.). May 1, 1969. Contract AT(11-1)-1088. 10p. Dep. CFSTI.

ELECTRONS—effects on polyethylene, mechanism and free radical yields from
  —effects on polyethylene, diene and cis- and trans- vinylene yields from
  —effects on isotactic propylene oxide polymers, ir and uv spectral studies on
  —effects on polyoxymethylene, effects of temperature on yields from
ETHYLENE POLYMERS—radiolysis of, spectral studies on free radical yields from electron
  —radiolysis of, diene and cis- and trans- vinylene yields from electron
FREE RADICALS—spectra of alkyl, uv absorption
  —radioinduced production of alkyl, allyl, and dienyl, effects of temperature on uv extinction coefficients for electron
  —radioinduced production of allyl and dienyl, effects of ir extinction coefficients for electron
  —conversion of alkyl to allyl, catalytic effects of hydrogen on decay constant for
HYDROGEN—effects on alkyl to allyl free radical decay constant, catalytic
POLYOXYMETHYLENES—radiolysis of, effects of temperature on yields from electron
PROPYLENE OXIDE—polymers, radiolysis of isotactic, ir and uv spectral studies on electron (P.C.H.)

26267 (NP-17819, Chap.2) PRODUCTION AND APPLICATION OF RADIOISOTOPES. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)). 7p.

Production of radioisotopes and labeled compounds, applications of gamma sources, and use of radioactive tracers are described. (M.C.G.)

26268 (RD/B/N-1311) THE RADIOLYSIS OF METHANE ADSORBED ON P.G.A. GRAPHITE AND COCONUT SHELL CHARCOAL. Dominey, D. A.; Swan, T. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Mar. 1969. 12p. Dep. CFSTI. UK.

The radiolysis of methane adsorbed on P.G.A. graphite and coconut shell charcoal was investigated at a number of surface coverages. No evidence was found for the sensitization of the radiolysis by transfer of energy from the solid to the adsorbed gas. (auth) (UK)

26269 (RFP-1299) RADIATION CHEMISTRY OF NITRIC ACID SOLUTIONS. Miner, Frend J.; Kazanjian, Armen R.; Brown, Alan K.; Hagan, Paul G.; Berry, James W. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Jan. 7, 1969. Contract AT(29-1)-1106. 12p. Dep. CFSTI.

Nitric acid solutions of varying concentrations were γ, α, and β irradiated. Solutions that were α or β irradiated were analyzed for nitrite only; solutions that were γ irradiated were irradiated under a variety of conditions and analyzed for all stable products. The results showed that the nitrite yields for γ and β irradiation were essentially the same. The yields increased with increasing HNO_3 concentration up to about 1 M, but then decreased. The nitrite yields from α irradiation were appreciably lower than the yields from γ and β irradiations at lower acid concentrations, but continually increased with increasing HNO_3 concentration. A possible mechanism, based on linear-energy-transfer (LET) effects is proposed. The effects of oxygen, acid concentration, and temperature on the nitrite yield from γ irradiation were also studied. Hydrogen peroxide yields and gaseous products were also determined for γ irradiation, the latter by mass spectrometry. (P.C.H.)

26270 (RPI-321-19) RADIATION CHEMISTRY OF GASES. Final Report. Harteck, P.; Dondes, S. (Rensselaer Polytechnic Inst., Troy, N. Y.). May 1969. Contract AT(30-3)-321. 19p. Dep. CFSTI.

The results of studies on the radiolysis of CO_2 and N_2-O_2 are briefly discussed. NO_2 was found to be an effective inhibitor in the decomposition of CO_2. The G-value for the CO_2 decomposition in the presence of NO_2 approached 10. NO_2 was only weakly decomposed into N_2 and O_2 and N_2O was also formed. In a search for more intense radiation sources, the possibility of using the impact of the fission recoil particles as a source of ionizing radiation in reactor experiments was investigated. An exceedingly intense radiation source was developed by using ^{235}U in the form of the oxide in contact with the gases to be studied, and the system was inserted into the nuclear reactor. (P.C.H.)

26271 (TID-25057) MAGNETIC RESONANCE STUDIES OF THE OXIDATION AND REDUCTION OF ORGANIC MOLECULES BY IONIZING RADIATIONS. Box, Harold C.; Freund, Harold G.; Lilga, Kenneth T.; Budzinski, Edwin E. (Roswell Park Memorial Inst., Buffalo, N. Y. Dept. of Biophysics). [1968]. Contract AT(30-1)-3558. 76p. Dep. CFSTI.

By maintaining organic compounds at low temperature (4.2°K) it is often possible to stabilize oxidation and reduction products produced by ionizing radiation. The products were observed by electron spin resonance (ESR) and in some cases by electron nuclear double resonance (ENDOR) spectroscopy. The oxidized and reduced species observed in irradiated single crystals of thiourea derivatives, several organic disulfides, thiodiglycolic acid, glycine, glycine-HCl, and two dicarboxylic acids are enumerated. Some G-values for ion production at 4.2°K are also given. The results are discussed in terms of the following processes; electron attachment, dissociative electron attachment, intramolecular transfer of holes, and anion degradation. (auth)

26272 HYDRATED ELECTRONS IN SEAWATER. Sallow, A. J. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Nature (London), 222: 369-70(Apr. 26, 1969).

A principal source of hydrated electrons in seawater is ^{40}K radiation; production from this source can be calculated from the potassium content of the oceans, the abundance and half-life of ^{40}K, the mean energy of the principal emitted radiation, and the energy yield of hydrated electrons (assumed to be the same as in pure water). The value obtained for global production is 3.1×10^2 moles/sec. Other radioactive sources can be neglected by comparison with ^{40}K. The contribution of cosmic rays to the total global production of hydrated electrons is about 4% of that of ^{40}K. Production by photolysis of organic compounds falls below that resulting from ^{40}K within about 35m of the surface. The hydrated electrons disappear mainly by reaction with O_2 and CO_2, and the first order rate constant for reaction with O_2 is $\sim 3.4 \times 10^6$ sec^{-1} and for reaction with CO_2 is 1.5 to 4×10^5 sec^{-1}. Typical rate constants were also obtained for reaction with other components of seawater. Adding these rate constants to those for O_2 and CO_2 the total rate constant for disappearance of hydrated electrons was found to be 3.8 to 4.0×10^6 sec^{-1}. From these data it is deduced that the permanent mean concentration at the surface of the oceans is $8 \pm 2 \times 10^{-25}$M, and in the bulk water $6 \pm 1.5\ 10^{-26}$M. In strong sunlight the surface concentration may rise to 10^{-15}M. The total permanent amount of hydrated electrons in the oceans is estimated as $8 \pm 2 \times 10^{-5}$M. The principal source of error is in the value adopted for the mean O_2 concentration. (U.K.)

26273 PRODUCTION OF ^{252}Cf AND OTHER TRANSPLUTONIUM ISOTOPES IN THE UNITED STATES OF AMERICA. Ferguson, Don E.; Bigelow, John Ealy (Oak Ridge National Lab., Tenn.). Actinites Rev., 1: 213-21(Mar. 1969).

Reactor production of ^{252}Cf and other transplutonium isotopes in the ORNL High-Flux Isotope Reactor with a ^{242}Pu target is reviewed. More than 300 g of transuranium isotopes have been produced in the 18-month period of operation through March 15, 1968. (J.G.B.)

26274 RADIOLYSIS OF GLASSY 2-PROPANOL AT 77°K. Kiss, F. (Research Inst. of Pure Chemicals, Brno). Collect. Czech. Chem. Commun., 34: 938-48(Mar. 1969).

By means of electron spin resonance method trapped electrons and $(CH_3)_2\dot{C}OH$ radicals were found to be the main intermediates in the radiolysis of 2-propanol in the glassy state at 77°K, the radiochemical yields being 1.9 and 3.95, respectively. Under the influence of visible light trapped electrons were transformed mostly into $(CH_3)_2\dot{C}OH$ radicals. Benzophenone anions were formed instead of trapped electrons in the presence of benzophenone in the yield 2.9, whereas the yield of $(CH_3)_2\dot{C}OH$ radicals was 2.7. Even those electrons were trapped by the benzophenone which in its absence give rise to $(CH_3)_2\dot{C}OH$ radicals, by neutralization of positive anions. Benzophenone anion is transformed by heating to the radical Ph_2COH. In addition to $(CH_3)_2\dot{C}OH$ radicals also other radicals appear in the radiolysis in a small yield which after a short exposure to ultra-violet light are transformed to $(CH_3)_2\dot{C}OH$ radicals. Final products found in the melted irradiated sample were hydrogen, methane, acetone and acetaldehyde. Their yields were greater if the sample was exposed to visible light before melting. Irradiation by uv light led to photolysis of the primary radicals and consequently to many times greater yields of the products. (auth)

26275 SOLVATED ELECTRON FORMED IN WATER BY THE SILENT ELECTRIC DISCHARGE IN ARGON ATMOSPHERE. Yokohata, Akira (Hiroshima Univ.). Bull. Chem. Soc. Jap., 42: 658-63(Mar. 1969).

On the basis of radiation chemistry of water a study on the chemical changes resulting from the silent electric discharge of aqueous solution under argon atmosphere was made for the purpose of elucidating the nature of the reducing species formed. In the neutral aqueous $ClCH_2COOH$ system the effects of such additives as CH_3OH and NO_3^- on the yield of Cl^- and in the system containing NO_3^- the yield of NO_2^- were investigated. Moreover, in the alkaline aqueous $K_3Fe(CN)_6$ system emphasis was placed on the yield of aquocomplex. In view of the non-dependence of the yield of Cl^- on the concentration of additive NO_3^- and of the low yields of NO_2^- and $Fe(CN)_5OH_2^{3-}$ produced, it was concluded that in the silent electric discharge the yield of solvated electrons which react with solutes in the bulk of water is very small ($G \lesssim 0.06$). Reasons for the low yield of solvated electrons are briefly described. (auth)

26276 AMINATION OF BENZOIC ACID IN THE γ-RADIOLYSIS OF LIQUID AMMONIA. Sakumoto, Akihisa (Japan Atomic Energy Research Inst., Tokai). Bull. Chem. Soc. Jap., 42: 755-60 (Mar. 1969).

Ammonia and aqueous ammonia solutions of benzoic acid, ^{14}C-carboxyl labeled, were irradiated with ^{60}Co γ-rays at absorbed doses of 1.9×10^{20} and 4.4×10^{20} eV/g, respectively. The irradiation temperature was 0°C in both cases. An isotope dilution method was applied to measure the products in irradiated solutions. The G values of o-, m-, and p-aminobenzoic acids were 0.016, 0.022, and 0.027, respectively, in an ammonia solution. On the other hand, the G values of products in an aqueous ammonia solution were 0.011, 0.013, and 0.017 for o-, m-, and p-aminobenzoic acids and 0.029, 0.033, and 0.040 for o-, m-, and p-hydroxybenzoic acids. The disappearance of benzoic acid in an ammonia solution corresponded to a G value of about 1.46. From the ratio of the relative partial rate factors, it was deduced that the aminating agent was the amino radical in both cases. (auth)

26277 RADIATION-INDUCED POLYMERIZATION OF VINYL MONOMERS IMPREGNATED IN WOOD. Kent, J. A.; Taylor, G. B.; Boyle, W. R.; Winston, A. W. (West Virginia Univ., Morgantown). Chem. Eng. Progr., 64: Symp. Ser. No. 83, 137-43(1968).

From American Inst. of Chemical Engineers Symposium, Detroit. See CONF-661201.

The radiation requirements and dose rate dependence of reaction rate for polymerizing several vinyl monomers impregnated in wood were determined. The monomers used were methyl methacrylate; 80% ethyl acrylate−20% acrylonitrile; 60% styrene−40% acrylonitrile; 88% methyl methacrylate−12% Phosgard C-22-R. Several species of wood were used: sugar maple, yellow poplar, white pine, birch, and loblolly pine. The rate curves for the polymerization of methyl methacrylate in wood at several dose rates indicate that an increase in dose rate reduces residence time but increases the radiation requirement. It was found that the dose requirement for complete polymerization of the polymers tested is a function of the radiation intensity raised to the 0.3 power over the range from 0.01 to 0.82 Mrad/hr for all woods tested except white pine. (auth)

26278 ULTRAHIGH-SPEED CURING OF POLYESTER PREPREGS AND WET LAY UP OF GLASS FIBER REINFORCED LAMINATES. Brenner, Walter (New York Univ., University Heights). Chem. Eng. Progr., 64: Symp. Ser. No. 83, 130-5 (1968).

From American Inst. of Chemical Engineers Symposium, Detroit. See CONF-661201.

Data are presented to show equivalence in pertinent physical strength properties of electron beam cured structures, compared with conventional peroxide cured materials. Economic process feasibility for this essentially instantaneous curing process is demonstrated. This technology, applicable to sheeting, tubular shapes, etc., eliminates curing ovens and greatly speeds up production cycles. (auth)

26279 RADIATION-INITIATED CROSSLINKING OF ORGANIC COATINGS. Hinsch, J. E.; Burlant, W. J. (Ford Motor Co., Dearborn, Mich.). Chem. Eng. Progr., 64: Symp. Ser. No. 83, 123-9(1968).

From American Inst. of Chemical Engineers Symposium, Detroit. See CONF-661201.

Polymerization kinetics and structure studies of model vinyl−divinyl systems subjected to both γ rays and high-energy electrons are summarized. From rate−intensity data, and with the help of several seemingly reasonable assumptions about electron radiation effects in liquids, the reaction rates with the volume elements and their size were established. These results were compared with those obtained by γ radiation. (P.C.H.)

26280 RADIATION-INDUCED ETHYLENE POLYMERIZATION PROGRAM AT BROOKHAVEN NATIONAL LABORATORY. Steinberg, Meyer; Kukacka, L. E.; Colombo, P.; Manowitz, Bernard (Brookhaven National Lab., Upton, N. Y.). Chem. Eng. Progr., 64: Symp. Ser. No. 83, 99-110(1968). (BNL-10442).

From American Inst. of Chemical Engineers Symposium, Detroit. See CONF-661201.

The experimental studies and evaluation of the program on radioinduced polymerization of ethylene, in progress at Brookhaven National Laboratory, are summarized. Kinetic data and product characteristics obtained in a series of constant pressure capsule and fall-through types of experiments are given. Experiments were performed at pressures from 170 to 1,920 atm, temperatures from 20 to 200°C, and radiation intensities from 5.8×10^4 to 8.5×10^5 rad/hr. With these data preliminary cost estimates for processes operating above and below the polymer melting point indicate conversion costs that may have economic potential. The current experimental program is concerned with the operation of a small-scale flow experiment. A description of the flow experiment and preliminary results are presented. (auth)

26281 REACTIONS OF ENERGETIC ^{18}F ATOMS WITH FLUOROMETHANES. FORMATION OF CH^{18}F AND CF^{18}F. Tang, Yi-noo; Small, Thomas; Rowland, F. S. (Univ. of California, Irvine). Contract AT(11-1)-34. J. Amer. Chem. Soc., 91: 2130-1(Apr. 9, 1969).

The energy deposition in reactions of energetic ^{18}F atoms with fluoromethanes is estimated through the observation of the secondary decomposition products. Results show that both CH^{18}F and CF^{18}F are formed in appreciable yields from the reactions of ^{18}F with CH_2F_2 or CHF_3, while CF^{18}F is formed from ^{18}F reactions with CF_4. These fluorocarbenes are among the anticipated secondary products based on the known elimination of HF in other fluorocarbon decompositions and were identified through their reactions with olefin scavengers to form the corresponding mono- or difluorocyclopropanes. The relative yields of the carbenes from excited $CH_2F^{18}F^*$ or $CHF_2{}^{18}F^*$ indicate that >80% of these molecules undergo decomposition at pressures of from 1 to 3 atm. The yield of CF^{18}F from $CF_3{}^{18}F^*$, for which the loss of F_2 or 2F is >8 eV endothermic, indicates about 50% decomposition of the excited molecule. Measured relative yields of $CH_2F^{18}F$, $CHF_2{}^{18}F$, and $CF_3{}^{18}F$ were in good agreement with those previously reported; however, the previously unreported fluorocyclopropanes were found in even larger yields in the olefin-scavenged system. (D.H.M.)

26282 ON THE CAPACITY LOSS OF THE ION-EXCHANGER DUOLITE C-63 BY γ-IRRADIATION. Stamm, H. H. (Kernforschungszentrum, Karlsruhe, Ger.); Papavassiliou, Or. Z. Anal. Chem., 244: 315-16(1969). (In German).

Duolite C-63 has a polystyrene matrix with 5.5% divinylbenzene; the functional phosphonic acid groups are core-fixed. Samples of the ion exchanger in the NH_4^+ form were irradiated for various times using a ^{60}Co γ source with a dose rate of 7.05×10^5 r/hr. The irradiated samples were mixed with a test solution containing Cu^{2+} ions. A linear decrease in the capacity of the ion exchanger with increasing radiation dose was observed. (M.C.G.)

26283 PHOTOLYTIC AND TEMPERATURE DECAY REACTIONS OF SPECIES ARISING IN RADIOLYSIS OF SOME RUBBERS AS STUDIED BY ESR AND RADIOTHERMOLUMINESCENCE TECHNIQUES. Kozlov, V. T.; Evseev, A. G. Vysokomol. Soedin., Ser. A, 11: 467-76(Mar. 1969). (In Russian).

By means of ESR and RTL photolytic and chemical transformations of reaction centers from the low temperature (77°K) radiolysis of elastomers, "Fhiton," Kel-7, Nairit A and B, SKTB-0.5 SKEP, and EPT were studied. The photosensitivity and paramagnetic particles (PP) formed by the radiolysis of fluorinated elastomers increase with variation of the wave length from 7000 to 2200 Å. Photosensitive PP approach their limit concentration at 1 to 15 MRAD and remain up to 120 MRAD. Free radicals especially the ones appearing at doses >10 MRAD are light-stable. In the course of heating elastomers Kel-F, Nairit A and B noticeable PP decay was observed in the region of T_g. It proceeded smoothly with gradual acceleration. An intensive flush of RTL was observed at 50 to 100° below T_g and was due to the neutralization of charged particles. Oxygen and oxygen-containing groups were the centers of luminescence. (auth)

26284 FORMATION OF ASPARTIC ACID FROM AQUEOUS MIXTURE OF MALEIC ACID AND AMMONIA BY γ-IRRADIATION. Rai, Tokan; Shinagawa, Mutsuaki (Osaka Univ.). Radioisotopes (Tokyo), 18: 171-4(May 1969).

The formation of an amino acid from maleic acid and an aqueous solution of ammonia by ^{60}Co γ-ray irradiation was studied. The irradiated solutions were analyzed by paper electrophoresis and amino acid analyzer. Aspartic acid was identified and estimated by spectrophotometry. The yield of aspartic acid formed was found to be dependent on the radiation dose and the concentrations of maleic acid and ammonia. The reaction mechanism was proposed as the combination of radicals induced by radiation. (auth)

26285 THE INFLUENCE OF OH-GROUPS ON THE RADIATION STABILITY OF BERYLLIUM FLUORIDE GLASSES. Margaryan, A. A. (Erevan Scientific Study Inst. of Chemistry. Leningrad Technological Inst.). Arm. Khim., Zh., 21: 459-62(1968). (In Russian).

In BeF_2 glasses a marked antiradiation effect of OH groups was not observed. Glasses of the composition BeF_2, 35%; AlF_3, 20%; CaF_2, 20%; SrF_2, 15%; MgF_2, 10%; and BeF_2, 54%; AlF_3, 10%; CaF_2, 12%; KF, 24%, were irradiated with a ^{60}Co source, accumulating a dose of 10^5 R. Ultraviolet, visible, and ir spectra before and after irradiation of both glasses are illustrated. Those samples containing OH absorption near 2800 nm showed no greater stability than samples with minimal absorption in this region. The results are interpreted in terms of the strength of the Be−F bond and its resistance to radiation damage even before the addition of OH groups, and compared with other results in similar systems. (BBB)

26286 RADIATION-INDUCED CURING OF PREPOLYMERS OF SOME CONDENSATION SYSTEMS. Kaetsu, Isao (Japan Atomic Research Inst., Takasaki); Hayashi, Koichiro; Okamura, Seizo. J. Macromol. Sci., Part A, 2: 1271-4(Oct. 1968).

Prepolymers of formaldehyde-urea, formaldehyde-melamine, and formaldehyde-phenol systems can be cured by the action of ionizing radiation, in the presence of certain additives such as methylene dichloride, $CHCl_3$, CCl_4, trichloroethylene, $AlCl_3$, NaCl, KCl, chloral hydrate, and poly(vinylchloride). The preparation of the formaldehyde-urea prepolymer used in this experiment is described completely. The curing time for the prepolymers varied, depending on the reaction conditions, and could be controlled by the suitable selection of such factors as the nature and amount of additives and the intensity and total dose of irradiation. The condensation reactions probably did not occur by the primary active species formed directly by irradiation, but may be indirect reactions caused by the catalytic intermediates formed by the radiolysis of the additives. (BBB)

26287 ELECTRON SPIN RESONANCE OF AN IRRADIATED SINGLE CRYSTAL OF L-TYROSINE-HCl. Fasanella, Edwin L.; Gordy, Walter (Duke Univ., Durham, N. C.). Proc. Nat. Acad. Sci. U. S., 62: 299-304(Feb. 15, 1969).

Analysis of the electron spin resonance (ESR) of a γ-irradiated single crystal of L-tyrosine-HCl reveals a free radical formed by loss of an H from the hydroxyl group attached to the ring. Principal g values of the radical are $g_x = 2.0023 \pm 0.0005$, $g_y = 2.0067 \pm 0.0005$, and $g_z = 2.0045 \pm 0.0005$, with g_x perpendicular to the plane of the ring and g_y along the CO bond to the ring. Analysis of the hyperfine structure of the spectra shows electron spin density on $C_{(2)}$ and $C_{(6)}$ to be 0.24 and on $C_{(4)}$ to be 0.32. Corresponding spin densities calculated from molecular orbital theory are 0.26 and 0.31, respectively. (auth)

26288 ORGANIC HALOGEN COMPOUNDS FOR CONDUCTIMETRIC DOSE-MEASUREMENT. Wolschendorf, K. (Univ., Kiel). Atomkernenergie, 14: 185-8(May-June 1969).

Saturated aqueous solutions of organic halogen compounds were subjected to x-irradiation for the purpose of studying their properties as conductimetric dosimeter-systems. The conductivity effect of the solutions investigated is determined and compared with the effect of the more commonly used chloral hydrate system. A simple reaction model was developed by which the radioinduced conductivity effect can be explained. Unlike the chloral hydrate system, the acid yield of most of the organic solutions studied showed no dependence on temperature within the range from 10°C to 60°C. Possible consequences for the reaction mechanism are discussed. A thorough comparison revealed that some of the solutions investigated are as applicable for conductimetric dose-measurement as the well-known chloral hydrate system. (auth)

26289 ELECTROMAGNETIC RESONANCE STUDY OF THE FREE RADICALS PRODUCED BY γ RADIATION IN SPHERICAL COMPOUNDS OF THE METHYLBUTANE SERIES. Gerola, Jocelyne (Centre d'Etudes Nucleaires, Grenoble, France); Lamotte, Bernard; Marx, Rose. J. Chim. Phys., 66: 216-20 (Feb. 1969). (In French).

Between 77°K and the melting point, the plastic crystals have a transition point which corresponds to the appearance of rotational motions of the molecules around their center of symmetry. For this reason, above the transition temperature, the electron spin resonance spectrum of free radicals in such compounds are similar to those of liquids. The radicals produced by gamma irradiation in the methyl substituted butanes were studied. (auth)

26290 SOME ASPECTS OF STAPLE FIBRE GRAFTING WITH ACRYLONITRILE UNDER THE ACTION OF γ RADIATION. Simionescu, Cr.; Feldman, D.; Ciubotariu, M. Celul. Hirtie, 18: 10-13(Jan. 1969). (In Rumanian).

The γ-radioinduced grafting of some staple fibers with acrylonitrile was studied. The formation of the grafted copolymers was proved by chemical and spectrophotometric analysis in the infrared field. Kinetics of the grafting reaction were studied as a function of the radiation dose. The grafted staple fibers were established roentgenographically by means of differential thermic, gravimetric, thermic, and thermomechanical methods as well as from the viewpoint of the physical and mechanical indexes. The fibers exhibited properties of thermostability to bacteria, elongation, and elasticity superior to the nongrafted staple fibers. (auth)

26291 STRESS-BIREFRINGENCE EFFECT IN CROSSLINKED POLYESTERS. PART 2. EFFECT OF γ-RADIATION ON PHOTOELASTIC EFFECT. Miki, Masanobu (Osaka Univ.); Wakihira, Loichiro. Oyo Butsuri, 38: 129-33(Feb. 1969). In Japanese).

The photoelastic effect in γ-irradiated crosslinked polyesters was investigated at various temperatures using the Sénarmont's compensator method with an automatic recording apparatus. The change in the photoelastic coefficient is similar to the change in the compliance of irradiated crosslinked polyesters. Since little change of the photoelastic coefficient and the compliance was obtained by irradiation, it can be considered that the photoelastic effect is predominantly determined by an instantaneous orientation of the backbone chain. (NSA of Japan)

26292 STRESS-BIREFRINGENCE EFFECT IN CROSSLINKED POLYESTERS. PART 3. EFFECT OF γ-RADIATION ON RETARDED-PHOTOELASTIC EFFECT. Miki, Masanobu (Osaka Univ.); Wakihira, Koichiro. Oyo Butsuri, 38: 134-40(Feb. 1969). (In Japanese).

The retarded photoelastic effect in γ-irradiated crosslinked polyesters was investigated at characteristic temperatures using apparatus described previously. The R. P. E. (retarded photoelastic effect) transition temperature was shifted to the higher temperature on irradiation by γ rays, and in some cases (in the vicinity of the R. P. E. transition temperature), a reversal in sign of the retarded photoelastic coefficient from positive to negative was observed. Above the glass transition temperature, the motion of the phenyl group of the side chain is almost not hindered sterically, even if the samples are irradiated. In the temperature range studied the retarded photoelastic coefficient is, therefore, hardly affected by radiation dose. The retarded photoelastic effect in irradiated crosslinked polyesters can be explained as the summation of two contributions, a positive contribution from phenyl groups in the backbone chain oriented parallel to the backbone plane, and a negative contribution from phenyl groups of the side chain oriented perpendicular to the backbone chain. (NSA of Japan)

26293 THE EFFECT OF γ IRRADIATION OF KU-2 SULFOPOLYSTYRENE IONITE ON PHENOL ADSORPTION. Skorokhod, O. R.; Stankevich, I. B. (Lenin Univ., Minsk). Kolloid. Zh., 29: 846-51(Nov.-Dec. 1967). (In Russian).

Phenol adsorption from dilute aqueous solutions was studied on nonirradiated and γ-irradiated (^{60}Co) specimens of sulfopolystyrene cationite KU-2 in the H^+ form containing 4, 5, 8, 12, 16, and 20% of divinylbenzene. Irradiated ionite samples exhibited higher phenol capacity than nonirradiated samples. Under the effect of γ irradiation the structure of water absorbed by ionite changed; the amount of free water became greater as compared to hydrate water. Partially sulfonated ionite at various degrees of reticulation adsorbed more phenol than the fully sulfonated ionite, with the increase of degree of reticulation phenol adsorption decreased. A decrease of temperature resulted in an increase of phenol adsorption. Changes of phenol adsorption free energy were calculated. (BBB)

26294 SEPARATION OF FISSION PRODUCTS BY RECOIL IN Φ_4Sn AND SUBLIMATION OF THE COMPOUNDS FORMED IN A TUBE WITH A TEMPERATURE GRADIENT: GAMMA RAYS FROM ^{134}Te. Blachot, J.; Carraz, L. C. (Centre d'Etudes Nucleaires, Grenoble, France). Radiochim. Acta, 11: 45-9(Mar. 1969). (In French).

The Φ_2Te*, Φ_3Sb*, ΦI* compounds are labeled from fission products recoiling in Φ_4Sn. They are then separated by fractional sublimation in a tube possessing a temperature gradient. The decay of ^{134}Te separated by this method was studied. (auth)

26295 COUPLING OF DYES TO VARIOUS MACROMOLECULES BY MEANS OF GAMMA IRRADIATION. Anderson, L. O. (Univ. of Uppsala). Nature (London), 222: 374-5(Apr. 26, 1969).

In the course of studies on the ability of various substances to protect serum albumin solutions against radiation damage it was found that some of these substances became bound to the albumin. A 1% bovine serum albumin solution of pH 7, containing 0.5 mM flourescein, was irradiated with 2×10^5R ^{60}Co γ-radiation at a dose rate of 184 R/sec. Dialysis against 0.1 M NaCl solution and water, or urea or phosphate buffer, showed that although most of the fluorescein could be removed, a part could not be separated from the protein. Irradiation of water solutions of polyglutamic acid, calf thymus DNA and polymethacrylic acid in the presence of fluorescein also resulted in some coupling of the dyestuff to the macromolecules. Coupling with serum albumin also resulted when using methylene blue, m-dinitrobenzene and N-DNP-glutathione. All these substances gave protection against radiation damage. In order to study if the irradiation and coupling of the dye had introduced conformational changes in the protein, measurements were made of the optical rotation and binding properties on the monomer fraction from a gel filtration of the serum albumin-methylene blue sample; it was concluded that little or no such change had taken place. Coupling mechanisms are discussed. It appears that the only condition necessary for coupling is that the substance employed is a good hydrogen donor. It is stated that these studies could be extended to the detection of radiation damage and radiosensitive sites. (UK)

26296 STUDY OF THE ELECTRON STRUCTURE OF RADICALS OF γ-IRRADIATED GLYCINE AND TYROSINE AND THEIR PHOTO-INDUCED REACTIONS. Kruglyak, Yu. A.; Pulatova, M. K.; Mozdor, E. V.; Sud'bina, E. N.; Pasoyan, V. G.; Kayushin, L. P. (Pisarzhevskii Inst. of Physical Chemistry, Kiev. Inst. of Biological Physics, Pushchino-on-Oka, USSR). Biophysics (USSR) (Engl. Transl.), 13: 480-94(1968).

Translated from Biofizika, 13: 401-12(1968).

The nature of the paramagnetic centers and the mechanism of their photoconversions in γ-irradiated glycine were studied. It has been established that in the poly- and monocrystals of glycine irradiated at −196°C a paramagnetic center appears in which the unpaired electron is localized on the carbon atom of the carboxyl group. The orientation of the given anion-radical in the elementary cell of the monocrystal has been determined. The spectral characteristics of the free radicals of glycine are given. A restricted method of the self-consistent field in a single-configuration approximation for closed and open shells and the method of interaction of electron configurations have been employed to calculate the electron structure of the ground state, the absorption spectra, the ionization potentials and the affinity for the electron of π-

fragments of glycine and L-tyrosine and some of their primary radicals. The nature of the free radical products of radiolysis of tyrosine has also been investigated. Assumptions are put forward on the appearance at −196°C in irradiated tyrosine of anion- and cation radicals and phenoxyl radicals of tyrosine. (auth)

26297 γ-RAY-INDUCED TERPOLYMERIZATION OF CARBON MONOXIDE, AZIRIDINES, AND CYCLIC ETHERS. Kagiya, Tsutomu; Kondo, Masatsune; Maruta, Isao; Fukui, Kenichi (Kyoto Univ.). J. Polym. Sci., Part A-1, 7: 351-62(Jan. 1969).

The terpolymerization of carbon monoxide, aziridines, and cyclic ethers was carried out by γ irradiation. A partially crystalline solid copolymer was obtained. The infrared spectrum of the copolymer obtained indicated characteristic peaks due to the secondary amide and ester groups. The results of elementary analysis, infrared spectra, and x-ray diffraction of the copolymer showed that terpolymerization of carbon monoxide, aziridine, and cyclic ether took place by γ irradiation. 2-Vinyl-1,3-dioxolane was polymerized in the system of carbon monoxide and ethylenimine to give a solid polymer. The infrared spectrum showed characteristics of the secondary amide and dioxolane ring, while no absorption due to carbonyl group of ester was observed. The infrared spectra and results of elementary analysis confirmed that the terpolymerization of carbon monoxide−ethylenimine−2-vinyl-1,3-dioxolane occurred. (auth)

26298 γ-RAY-INDUCED COPOLYMERIZATION OF CARBON MONOXIDE WITH CYCLIC ETHERS. Kagiya, Tsutomu (Kyoto Univ.); Kondo, Masatsune; Fukui, Kenichi; Yokota, Hisao. J. Polym. Sci., Part A-1, 7: 183-99(Jan. 1969).

The γ-ray copolymerization of carbon monoxide with cyclic ethers, such as ethylene oxide, phenyl glycidyl ether, 1,3-dioxolane, 2-vinyl-1,3-dioxolane, tetrahydrofuran, 1,4-dioxane, and acetaldehyde was studied. A yellowish or brownish powdery copolymer was obtained in most of the cases examined. The infrared spectra showed that copolymers containing the ester structural unit were produced in the copolymerization with cyclic ethers which have no vinyl groups, and that a copolymer containing a ketone structure was produced from cyclic ether having vinyl group. It was found that the copolymer with ethylene oxide also had a β-propiolactone ring structure at the chain end or the side chain. The copolymers were confirmed to be partially crystalline from the x-ray diffraction diagrams. Further, a ring-opening polymerizability of the cyclic ether by γ radiation is discussed. It was found that as the bond dissociation energy between the carbon−oxygen linkage of the cyclic ether is small, the polymer yield both in the homopolymerization and copolymerization with carbon monoxide is high. A mechanism for the copolymerization is proposed on the basis of the results. (auth)

26299 SOLVENT-SENSITIZED RADIOCHEMICAL REACTIONS. II. FRIES REARRANGEMENT OF ARYL ESTERS AND ARYL AMIDES. Bellus, D. (Inst. for Polymers, Bratislava); Schaffner, K.; Hoigne, J. Helv. Chim. Acta, 51: 1980-9(1968). (In German).

In screening experiments p-tolyl acetate, phenyl benzoate, p-tolyl benzoate, acetanilide, and 2-naphthyl acetate were subjected to γ radiolysis in aromatic and saturated hydrocarbon solutions. Qualitatively, the products formed correspond to those observed also with the respective photo-Fries reactions, i.e., hydroxy- and amino-aryl ketones due to rearrangements, and products due to homolytic fission into aryloxy and aniline radicals, respectively, were produced. The relatively high G values of conversion in dilute solutions indicate that energy transfer from the solvent is operative, e.g., 0.1M p-tolyl acetate in benzene has a G value of over 0.3 for ortho-rearrangement and of 0.55 for cresol formation. Kinetic evidence points to different energy requirements of the ortho-rearrangement and the phenol formation, and to more than one excited state of benzene acting as energy donor. The ratio of the observed rate constants of the energy transfer to self-quenching in benzene is about 80 l/mole for the ortho-rearrangement. The overall reaction is strongly quenched on addition of p-terphenyl. A comparison of the quantitative data obtained here with available published data reveals differences between benzene-sensitized runs with γ radiation and photochemical experiments. Thus, the ratios of ortho vs para and amphi rearrangement, and of homolytic fission vs rearrangements are higher in the solvent-sensitized radiolyses. (BBB)

26300 SOLID STATE POLYMERIZATION OF HEXAMETHYLCYCLOTRISILOXANE BY γ-RAY IRRADIATION. Yamakita, Hiromi (Government Industrial Research Inst., Nagoya, Japan); Ballantine, D. S. Radioisotopes (Tokyo), 18: 85-90(Mar. 1969). (In Japanese).

The solid state polymerization of hexamethylcyclotrisiloxane by γ-irradiation in air was studied in the temperature range of −78 to 55°C. It was found that the rate of polymerization depends on the size of the reaction vessels at relatively high temperatures, and that the polymerization reaches a limiting conversion, usually about 30 to 50%. The conversion-time curves suggest that the reaction is retarded owing to the formation of polymer. The temperature dependence of the polymerization rate was unusual between −78 and 0°C, which seems to be related to a phase transition of monomer crystal. The initial rate of polymerization at 55°C was approximately proportional to the first order of dose rate. The rate of polymerization at 55°C for the sample prepared by slow-cooling was higher than that prepared by shock-cooling. In order to explain these results, a kinetic scheme was assumed which includes the self-retarding effect of the polymerization. The polymerization was studied also by a microscopic technique. The observations with a phase contrast microscope and a polarized microscope proved that the reaction involves the formation of polymer particles and proceeds heterogeneously, and that there is no particular direction of the propagation. (auth)

26301 RADIATION-CHEMICAL GRAFTING OF VINYL CHLORIDE TO POLYETHYLENE FILM. Tikhomirov, V. S.; Popova, A. I.; Serenkov, V. I. Plast. Massy, No. 3, 14-16(1969). (In Russian).

Results of an investigation of the kinetics of gas-phase radiation-chemical grafting of vinyl chloride to polyethylene film are presented. It was established that the grafting is proportional to the dose and does not depend on the thickness of the film. The reaction is second order according to vapor pressure and the activation energy is ~5.4 kcal/mole and close to the activation energy for homopolymerization of vinyl chloride. The graft polymerization process proceeds according to an ionic mechanism. (tr-auth)

26302 RADIOLYTIC OXIDATION OF CYSTEINE. Owen, Terence C.; Brown, Marcus T. (Univ. of South Florida, Tampa). J. Org. Chem., 34: 1161-2(Apr. 1969).

The radiolysis of cysteine in acid buffer solutions is reported. The yields of cystine and hydrogen peroxide from x-irradiation of aqueous cysteine solutions were approximately equal and increased with increasing thiol concentration. At the highest cysteine concentration studied (30 mM) the yield of destruction of thiol was only three times the yield of primary radicals from water. Solutions irradiated at intermediate pH (4 to 5) were also studied. (D.H.M.)

26303 RADIATION-INDUCED SOLID-STATE POLYMERIZATION OF SOME N-ALKYL MALEIMIDES. O'Donnell, J. H.; Sothman, R. D. (Univ. of Queensland, Brisbane). J. Polym. Sci., Part B, 7: 129-34(Feb. 1969).

Preliminary results on the γ-radioinduced polymerization of eight N-alkylmaleimides are reported. At radiation doses of 1.5 and 3.0 Mrad and temperatures of about 10° below the melting points of the maleimides, polymer yields from methylmaleimide wave considerably higher than those for the other maleimides. Yields from the post-irradiation polymerization of solid N-alkylmaleimides at −196°C and at various doses up to 5 Mrad were low. Greatly increased post-irradiation polymerization of dodecylmaleimide was observed when the solid monomer was melted under vacuum, the liquid degassed, and then allowed to solidify. (J.G.B.)

26304 BEHAVIOR OF PEROXY RADICALS TRAPPED IN γ-IRRADIATED POLYPROPYLENE AS STUDIED BY ELECTRON SPIN RESONANCE. Eda, Bunzo; Nunome, Keichi; Iwasaki, Machio (Government Industrial Research Inst., Nagoya, Japan). J. Polym. Sci., Part B, 7: 91-7(Feb. 1969).

The effects of experimental conditions on the formation of γ-radioinduced peroxy radicals and subsequent hydrogen abstraction reactions in polypropylene were studied. ESR spectra of peroxy radicals in samples irradiated at −78°C in the presence of oxygen exhibited a marked temperature dependence while those irradiated at room temperature showed little temperature dependence and gave similar line shape at −78°C and at −196°C. It is concluded that the radicals trapped in the amorphous region decayed during irradiation, leaving the radicals trapped in the more rigid matrices, when irradiated at room temperature. Measurements of isothermal decays confirmed the influence of surrounding matrix on the decay of radicals. (J.G.B.)

26305 IONIZING IRRADIATION POLYMERIZATION OF TRIOXANE. Marens, Nelson S.; Jaffe, Fred (to W. R. Grace and Co.). U. S. Patent 3,438,883. Apr. 15, 1969. Filed Dec. 2, 1966.

A method for preparing high molecular weight fibers of polyoxymethylene is presented which comprises preparing trioxane crystals having a length exceeding about 1 mm., irradiating said crystals with about 0.02 to 5.0 megaRADS of high-energy ionizing radiation at a temperature below 25°C, aging the irradiated trioxane at about 25 to 60°C for a period sufficient to allow substantial polymeric growth, and removing nonpolymerized trioxane from the aged crystals. (AEC)

26306 ELECTRON SPIN RESONANCE STUDIES OF γ-IRRADIATED AQUEOUS ALKALINE SOLUTIONS OF ACRYLAMIDE AT 77°K. Seddon, W. A.; Smith D. R. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Chem., 45: 3083-8(Dec. 15, 1967). (AECL-2970).

The γ radiolysis of acrylamide in 8 $\underline{M}$ NaOH solutions in H_2O and D_2O at 77°K results in the formation of $CH_3\underset{\cdot}{C}HCONH_2$ ($Hm_1\cdot$) and $CH_2D\underset{\cdot}{C}HCONH_2$ ($Dm_1\cdot$) radicals, with a maximum yield $G(Hm_1\cdot) = 1.9$ molecules/100 eV. Since in the absence of acrylamide the yield of trapped electrons, $G_0(e_t^-)$, = 1.9, it appears that the precursor of $Hm_1\cdot$ is a radical anion ($m_1\cdot^-$), which then abstracts a proton from the solvent according to $m_1\cdot^- + H_2O \rightarrow Hm_1\cdot + OH^-$. In support of this interpretation we find that $Hm_1\cdot$ is also formed in similar media as a result of (a) "photo-bleaching" of trapped electrons or (b) photo-detachment of electrons from ferrocyanide ion with light of wavelength 2 537 Å. This is confirmed by the electron spin resonance (ESR) spectra obtained from methacrylamide and acrylonitrile in γ-irradiated alkaline ice. The concentration dependence of electron scavenging by acrylamide indicates that the electrons diffuse over distances of up to 170 Å prior to trapping or capture by the solute. (auth) (CANADA)

26307 PULSE RADIOLYSIS APPARATUS FOR MONITORING AT 2000 A. Christensen, H. C. (Aktiebolaget Atomenergi, Studsvik, Sweden); Nilsson, G.; Pagsberg, P.; Nielsen, S. O. Rev. Sci. Instrum., 40: 786-9(June 1969).

A pulse radiolysis apparatus with photometric monitoring has been built around an 11-MeV, 250-mA peak current, linac that delivers single 0.25- to 4-μsec pulses. The novel features of the apparatus include (1) a 450-W xenon lamp as the analyzing light source which in pulsed operation had a 25 times increased luminance; (2) a fast electronic switch that cut out the signal due to the Cherenkov radiation; (3) a secondary emission chamber that allowed the simultaneous measurement of the current and the direction of the pulsed electron beam; and (4) a system for remote controlled change of liquid samples stored in glass syringes. Reliable measurements of optical transmission could be made starting 0.2 μsec after the electron pulse at wavelengths down to 2000 Å on transient species having products of yield and absorptivity $G \times \epsilon > 500$ mole $(100\ eV)^{-1} \cdot liter^{-1} \cdot cm^{-1}$. (auth)

26308 COMPARATIVE STUDY OF ELECTRON PARAMAGNETIC RESONANCE AFTER RADIOLYSIS AND PHOTOLYSIS OF A DURENE MONOCRYSTAL. Fric, Claude; Heurtaux, Jacques; Martin-Bouyer, Michel (Institut d'Etudes Nucleaires, Algiers). Compt. Rend., Ser. B, 283: 694-7(Mar. 3, 1969). (In French).

The emission spectra of durene irradiated with γ rays and with ultraviolet radiation were identical. Having obtained an electron paramagnetic signal by γ irradiation, an attempt was made to reproduce this signal by simple ultraviolet irradiation and a spectrum of the same structure appeared. (tr-auth)

26309 RADIOLYSIS AND RADIATION OXIDATION OF POLY-ϵ-CAPROAMIDE IN PRESENCE OF SOME ANTIOXIDANTS. Furman, E. G.; Fomenko, A. S.; Abramova, T. M.; Dar'eva, E. P.; Spirina, I. A. (Inst. of Physical Chemistry, Kiev). Vysokomol. Soedin., Ser. A, 11: 836-43(Apr. 1969). (In Russian).

The effects of 4-hydroxydiphenylamine type ethers and phenols on radiolysis and radiation oxidation of poly-ϵ-caproamide were investigated. The compounds decreased radiation yields of free radicals, hydrogen, and carbon monoxide, number of scissions of the polymer chain in vacuo, radiation yield of peroxide, also number of chain scissions in oxygen. Data on di-β-naphthyl-p-phenylenediamine uptake in a course of radiation oxidation of poly-ϵ-caprolactam were obtained. Protective effects of the additives can be explained on one hand by dissipation of excitation energy from polymer molecules before bond breakage and on the other hand by termination of oxidation chains due to transfer of a mobile hydrogen atom from additive to peroxide radicals. (auth)

26310 LOW TEMPERATURE RADIATION POLYMERIZATION OF ACROLEIN IN SOLID STATE POST-POLYMERIZATION. Finkel'shtein, E. I.; Abkin, A. D. (Karpov Inst. of Physics and Chemistry, USSR). Vysokomol. Soedin., Ser. A, 11: 855-60(Apr. 1969). (In Russian).

The kinetics of solid-state post-polymerization of acrolein γ-irradiated at −196° were considered. It is proposed that the reaction is diffusion-controlled, and the kinetic equation for post-polymerization was derived. The self-diffusion coefficient $D_{0\gamma}$ self-diffusion entropy of activation, concentration of excess vacancies, and activation energies of rising and diffusion of vacancies in the solid monomer were calculated. It is proposed that solid state post-polymerization be used for the determination of self-diffusion parameters in crystalline monomers. (auth)

26311 PECULIARITIES OF STRUCTURE OF FILLER SURFACE MODIFIED BY RADIATION GRAFTING OF POLYMERS. Blyskosh, G. S.; Yanova, L. P.; Taubman, A. B.; Ryabchikova, G. G. (Inst. of Physical Chemistry, Kiev). Vysokomol. Soedin., Ser. A, 11: 900-4(Apr. 1969). (In Russian).

The surface of magnesium oxide modified by radiation grafting of gaseous acrylonitrile, methyl methacrylate, and styrene polymers was investigated by sorption of nitrogen in vacuo, stearic acid, and perchlorovinyl from toluene solution. Even for high amounts of grafted polymers parts of the surface remain untouched resulting in a mosaic surface. (auth)

26312 RADIATION COPOLYMERIZATION OF METHYL MALEATE WITH STYRENE. Shcherbina, F. F.; Bakumenko, O. I. (Inst. of Physical Chemistry, Kiev). Vysokomol. Soedin., Ser. A, 11: 776-6(Apr. 1969). (In Russian).

The effects of composition of the monomeric mixture, dose rate, time, and temperature on the γ-radioinduced copolymerization of methyl maleate with styrene in an argon atmosphere was studied. (auth)

Radiochemistry

26313 (AED-C-12-18) BIBLIOGRAPHIES IN NUCLEAR SCIENCE AND TECHNOLOGY. SECTION 12. NUCLEAR SCIENCE LITERATURE OF EASTERN COUNTRIES. NUMBER 18. RADIOCHEMISTRY. ISOTOPES. Ensslen, Benno (comp.) (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). Dec. 1968. 377p. (In German and English). Dep.

References (1705) to journals, books, and conferences published from 1961 to 1967 are given. All the references were published by Eastern countries. The subjects covered include: general fundamentals of radiochemistry; production of radioisotopes; behavior of carrier-free isotopes; chemical reactions following nuclear processes; special physical nuclear chemistry; chemistry of the radioelements; nuclear fuels; production of radioactive preparates; special separation methods; applied radiochemistry; radiation chemistry; radiation control and protection; and radiation measuring techniques. A separate author index is included. (P.C.H.)

26314 CHEMICAL EFFECTS ASSOCIATED WITH β-DECAY PROCESS. IV. KINETIC STUDIES OF THE CHEMICAL BEHAVIOR OF ^{144}Pr DECAYED FROM THE ^{144}Ce(III)-DIETHYLENETRIAMINEPENTAACETATE COMPLEX. Shiokawa, Takanobu; Omori, Takashi (Tohoku Univ., Sendai). Bull. Chem. Soc. Jap., 42: 696-701(Mar. 1969).

The chemical behavior of ^{144}Pr as a result of the β^--decay of the ^{144}Ce(III)−diethylenetriaminepentaacetate [^{144}Ce(III)−DTPA] complex was investigated in detail on the basis of the substitution reaction mechanism. The experimental results, represented in terms of the yield of the ^{144}Pr(III)−DTPA complex, were explained quantitatively by the application of Bateman's equation. An increase in the nuclear charge in the β^--decay of the ^{144}Ce(III)-DTPA complex may result in the formation of ^{144}Pr(IV)-DTPA. which would then be reduced to an intermediate complex of ^{144}Pr(III) by an intramolecular electron-transfer. The mechanisms and the rate constants are established for the decomposition of the intermediate leading to the formation of the uncomplexed ion. It was also suggested that the uncomplexed ^{144}Pr(III) ion is produced directly by an exhaustive bond-rupture of the daughter complex ion, without any formation of the intermediate. The ratio of bond-rupture was determined to be 0.25; this value is in accordance with the theoretical value for the formation of the multiply-charged ^{144}Pr ion due to electron shake-off and the internal conversion of γ-rays, followed by the Auger process. (auth)

26315 RADIOACTIVE DECONTAMINATION. Buist, Daniel T. (to Purex Corp., Ltd.). U. S. Patent 3,437,521. Apr. 8, 1969. Filed Jan. 21, 1964.

A process for removal of radioactive contaminants from the surface of an article comprises contacting the article with a hot fluid medium containing a decontaminating agent effective for removal of radioactive contaminants, cooling the article contacting it with hot vapors of a chlorinated hydrocarbon solvent at a temperature above the temperature of the cooled article, and causing the vapors to condense on the article and drain from the surface rinsing the surface. (Offic. Gaz.)

26316 PHENOMENA INVOLVING NEUTRON CAPTURE BY SELECTED COBALT COMPLEXES. I. Stucky, Gary L.; Kiser, Robert W. (Kansas State Univ., Manhattan). Radiochim. Acta, 11: 5-19(Mar. 1969).

The identification of radiolabeled degradation products and other phenomena involving the neutron irradiation of five different cobalt complexes is reported. Solvent and pH effects upon degradation product distribution in solution are noted. Electrophoretic and chromatographic analysis correlation for radiolabeled decomposition products is discussed. Results of studies involving mass spectrometry, magnetic susceptibility, x-ray diffraction, and infrared spectroscopy are also reported. The conclusion is drawn that there is an even larger number of factors affecting degradation product distribution for neutron-irradiated cobalt complexes than previously known. (auth)

Separation Processes

Refer also to abstracts 26153, 26171, 26172, 26191, 26313, 26580, 28423, 28603, and 28604.

26317 (AEC-tr-7045) STUDIES ON THE CLARIFICATION AND COALESCENCES TIME OF COLLOIDAL ANN–HNO_3–Hg^{+2} SOLUTIONS IN THE PRESENCE OF ORGANIC PHASES OF TCAN-SOLVESSO 100 AND TBP-SHELLSOL T. Beone, G.; Moccia, A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). Translation of report RT/CHI–(65)-33. 18p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 20: 29333. (auth)

26318 (ANL–7550) CHEMICAL ENGINEERING DIVISION RESEARCH HIGHLIGHTS, MAY –DECEMBER 1968. (Argonne National Lab., Ill.). Contract W-31-109-eng-38. 118p. Dep. CFSTI.

A separate abstract was prepared for each of the six sections presented. (W.H.K.)

For abstracts of individual sections see: 26209, 26319–26321, 27409, and 28270.

26319 (ANL–7550, pp 7-22) COMPACT PYROCHEMICAL PROCESSES. (Argonne National Lab., Ill.).

Studies on salt transport separation as the means of recovery and purification of ceramic fuels for fast breeder reactors are reported. The separation is based on the selective transfer of a solute (Pu or U) from one liquid metal solution to another by the cycling of a molten chloride salt between the two metal solutions. Investigations were conducted on various phases of the pyrochemical process, including fuel decladding, the reduction of fuel pellets with a molten $CaCl_2$–CaF mixture and a liquid Mg–Cu–Ca alloy, solubility of Pu in liquid Mg–Zn alloys, and partial phase diagrams and thermodynamics of the Cd–Np system. Work was initiated on a pyrochemical purification of ^{238}Pu. (J.G.B.)

26320 (ANL–7550, pp 23-34) FLUORIDE VOLATILITY PROCESS. (Argonne National Lab., Ill.).

Process and engineering flowsheets were prepared for a large fluoride volatility plant. The basis for the fluoride volatility processing method is the reaction of fluorinating agents with fuel materials in fluid-bed systems to produce the volatile hexafluorides of uranium and plutonium, which are separable from nonvolatile fission product compounds. Additional separation procedures are necessary to produce purified UF_6 and PuF_6. An effort was made to establish optimum processing conditions for fluorinating simulated spent fast breeder reactor fuels. Results of supporting studies are reported on the reaction of NpF_6 with NaF, the sorption of ruthenium fluorides on a bed of particulate LiF, the identification of ruthenium fluoride species by sublimation of mixtures of UF_6 and ruthenium fluorides, and the filtration of PuO_2F_2 aerosol by fiber filters. (J.G.B.)

26321 (ANL–7550, pp 97-9) FLUIDIZED-BED COMBUSTION OF FOSSIL FUELS. (Argonne National Lab., Ill.).

An investigation on pollution control aspects of fluidized-bed combustion of fossil fuels was initiated. Preliminary experiments involved additives believed suitable for reacting with pollutants, SO_2, H_2S, or NO_x, in a fluidized-bed. Additives tested for SO_2 removal at 1700°F were dolomite, phosphate rock, spent oil shale, red mud, lead oxide, manganese oxide, nickel oxide, copper oxide, cobalt oxide, and zinc oxide. Dolomite far outperformed the other materials studied. (J.G.B.)

26322 (CEA-CONF–1264) STUDY OF THIRD PHASE FORMATION IN TRILAURYLAMINE SOLUTIONS. Gourisse, D. (Commissariat a l'Energie Atomique, Fontenay-Aux-Roses (France). Centre d'Etudes Nucleaires). [1966]. 18p. (CONF-680953–1). Dep.

From 5th International Conference on the Chemistry of Extraction by Solvents, Haifa and Jerusalem, Israel.

Light scattering experiments, ultracentrifuge experiments, and viscometry were used to study third (or heavy) phase formation in tridodecylamine solutions. It was found that the micelle size increases sharply before splitting of the organic solution. An acid system (TLA–tetradecane–HNO_3) and a metal system (TLA–cyclohexane–HNO_3–Th) were used as examples of systems in which splitting occurs. These systems were compared at 30°C with TLA–dodecane–HNO_3 and TLA–xylene–HNO_3–Th systems in which no splitting occurs. Scattered light intensity showed a sharp specific increase in the vicinity of third phase formation. Comparison between solutions of the same concentrations in different diluents showed that a sharp increase in micelle size is specific for splitting phenomenon. (P.C.H.)

26323 (CEA-CONF–1271) THEORY OF ISOTOPIC SEPARATION BY GASEOUS DIFFUSION ACROSS A MEMBRANE. EFFECT OF THE INTERNAL STRUCTURE OF THE MEMBRANE. Breton, Jean-Paul. [1968]. 15p. (In French). (CONF-681015–4). Dep.

From Symposium on Problems Bearing on Isotope Separation of Uranium, Turin, Italy.

It is possible to interpret by calculation, at least qualitatively, the influence of the structure of the porous medium on the flux and the efficiency of separation by introducing a distribution coefficient P_c that is a function of the length (λ) of the segments supported by the partition. Unfortunately, it appears that this distribution $P_c(\lambda)$, or the structure of the porous region, cannot be favorable simultaneously to the permeability and to the efficiency of separation. (tr-auth)

26324 (CONF-670649–42) EXTRACTION, BY ORGANIC SOLVENTS, OF RADIOACTIVE NUCLIDES PRESENT IN AQUEOUS SOLUTIONS. Lopez Varona, J. L. (Valladolid Univ. (Spain). Facultad de Ciencias). [1967]. 24p. (In Spanish). Dep.

From Symposium on Applications of Radioisotopes, Madrid, Spain.

Organic extraction agents are classified according to the chemical reactions occurring in the extraction and the interactions between solvent and solute. The properties of amines as extractants of radioactive nuclides are discussed. The compounds dinonylamine, didodecylamine, bis(3-ethylheptyl)amine, bis(3,7-dimethyloctyl)amine, bis(2-methylundecyl)amine, trinonylamine, tridodecylamine, tris(3-ethylheptyl)amine, tris(3,7-dimethyloctyl)amine, and tris(2-methylundecyl)amine were prepared and their extractive capacity studied. Experimental studies made with the extraction of U in sulfuric acid solution are described. Factors affecting the extraction coefficient were also studied, and the results obtained are illustrated graphically. (tr-auth)

26325 (JUL–544-DE) INVESTIGATION OF PROCEDURES FOR CHEMICAL OXIDATION OF RADIOACTIVE SEWAGE. Schulze-Rettmer, R.; Schlenter, W. (Kernforschungsanlage, Juelich (West Germany)). Aug. 1968. 38p. (In German). Dep.

Radioactive sewage from the Radiation Clinic of the Juelich Institut fuer Medizin is treated by chemical oxidation. The sewage processing plant has been in operation for four years. Ammonium peroxodisulfate is added to the sewage at about 80°C and the biological constituents of the sewage are destroyed by oxidation. Studies made to determine the most favorable conditions for the oxidation and the special analytical methods developed to control the efficiency of the method are described in detail. Analytical determination of the organic carbon in aqueous solution, the stability and decomposition of some perosodisulfate compounds, determination of potassium permanganate in the presence of peroxodisulfates, effect of peroxodisulfate on the determination of the biochemical oxygen needs, and behavior of iodine in the chemical oxidation are considered. The sewage treatment plant is described. (J.S.R.)

26326 (KFK–867) ^{1}H AND ^{31}P NMR INVESTIGATIONS OF EXTRACTION PROPERTIES OF ORGANIC PHOSPHORUS COMPOUNDS. I. THE SYSTEM TRIBUTYL PHOSPHATE–DODECANE–HNO_3–H_2O. von Ammon, R.; Baumgaertel, G. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Heisse Chemie). Nov. 1968. 22p. (In German). Dep.

Nuclear magnetic resonance was used to study the behavior of TBP in simple systems. The extraction of H_2O and HNO_3 by TBP and TBP–dodecane mixtures was studied by chemical shifts in the lines of the NMR spectra of ^{1}H and ^{31}P. The ^{31}P nuclear resonance offers a possibility for determination of HNO_3 in dilute TBP solutions. (M.C.G.)

26327 (KFK–884) REPROCESSING PROBLEMS ASSOCIATED WITH THE INCREASING BURN-UP OF FUTURE FUELS. Baumgaertner, F. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Heisse Chemie). Dec. 1968. 14p. (CONF-681040–12). Dep.

From Symposium on Nonaqueous Reprocessing, Mol, Belgium.

The problems in reprocessing nuclear fuels associated with increased burnup of future uranium and plutonium oxide fuels are the high fission product concentrations with the corresponding amounts of volatile iodine and tritium. Furthermore, self-heating in the head-end stage and rapid off-gas release during the disintegration step will cause problems. On the other hand, the aqueous process probably will not fail even with higher burnup and shorter cooling times. Future reactor projects such as the High-Temperature-Gas-Cooled Thorium-Reactors or Fused Salt Reactors may need a nonaqueous method. Nonaqueous methods may also take over steps of the reprocessing operation if this would make the overall process more economical. (auth)

26328 (RFP-Trans-55) OXIDATION-REDUCTION OF PLUTONIUM IN THE TREATMENT OF SPENT FUELS. Chesne, A. Translated by A. R. Kazanjian from Bull. Inform. Sci. Tech. (Paris), No. 127, 27-33(June 1968). 21p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 22: 47224.

26329 (ORNL-TM-2567) CHEMICAL APPLICATIONS OF NUCLEAR EXPLOSIONS (CANE). Progress Report for January 1–March 31, 1969. Arnold, W. D.; Crouse, D. J. (comps.) (Oak Ridge National Lab., Tenn.). Apr. 24, 1969. 16p. Dep. CFSTI.

In studies of the effects of nuclear explosives on copper ore processing, the ^{106}Ru contamination of the cement copper product decreased with increase in the copper concentration in the leach liquor and with decrease in the amount of excess iron used for cementation. Contamination of oil shale or retorted oil with tritium was not significantly higher after 106 days exposure of the shale to tritiated water vapor at 85°C than after 29 days exposure. The efficiency with which tritium was removed from the contaminated shale with moist air at 200°C also was not affected by this change in exposure time. Only small amounts of tritium were removed from contaminated oil samples by heating under reflux for 24 hr with water, 0.1 $\underline{N}$ NaOH, or 0.1 $\underline{N}$ H_2SO_4. The design of the apparatus for analysis of natural gas samples was completed and the necessary equipment and supplies were ordered. Fabrication of the support rack and vacuum system was started. (auth)

26330 (SRO–344-1) WEST VALLEY REPROCESSING PLANT. Quarterly Report [No. 11], October 1–December 31, 1968. (Nuclear Fuel Services, Inc., West Valley, N. Y.). Jan. 31, 1969. 20p. Dep. CFSTI.

The processing of NPR Lot X was completed and the processing of Core A from Consolidated Edison's Indian Point Reactor begun. Nuclear material accountability records indicate the disposition of nuclear material in fuel at the reprocessing plant. Processing and disposal of waste is discussed. Environmental monitoring and facility performance and modification are described. (M.C.G.)

26331 SEPARATION OF RADIORUTHENIUM ON A CHELATING RESIN. Kepak, F.; Kriva, J. (Inst. of Nuclear Research, Prague). Collect. Czech. Chem. Commun., 34: 1101-3(Mar. 1969).

A chelating resin, having the general structure $[R-C(:NH)\cdot NH_3^+]_n Cl_{n3}^-$ was used for the separation of micro-amounts of Ru(III) ions from aqueous solutions. (J.G.B.)

26332 PREPARATION OF PRODUCTS FROM MILK TREATED WITH CATIONIC RESIN FOR REMOVING RADIONUCLIDES FROM MILK. Murthy, G. K. (Dept. of Health, Education, and Welfare, Cincinnati). J. Dairy Sci., 52: 629-32 (May 1969).

Standard procedures were employed to make cultured milk, butter, and Cheddar cheese from resin-treated milk that was acidified to pH 5.35 with citric acid, passed through IR-120 (Ca : Mg : K : Na) resin, and neutralized to pH 6.8 with KOH. A portion of the untreated milk served as the control. When Cheddar cheese was prepared from the treated milk, the procedure varied: About 6 ml of M $CaCl_2$ per liter of milk were added and the curd cooked at 36.5 C. Comparison of test results for the treated samples with those for the controls showed that because of excess citric acid, proper selection of cultures is necessary to obtain good-quality cultured milk having comparable diacetyl content and flavor. A short-term test on keeping quality of butter stored at room temperature revealed that resin-treated samples had better keeping quality. This is attributed to a slight depletion of copper content of milk as a result of resin treatment and presence in the butter sera of excess citric acid, which behaves like a synergist. Other than a slight improvement in the flavor, no significant differences in some of the observed physical and chemical properties of cheddar cheese were noted. (auth)

26333 FACTORS GOVERNING THE CHOICE OF A ^{237}Np/^{238}Pu SEPARATION PROCESS. Jenkins, I. L. (Atomic Energy Research Establishment, Harwell, Eng.). Actinides Rev., 1: 187-211(Mar. 1969).

Precipitation, electrolytic, solvent extraction, and ion exchange methods are considered for the separation of ^{238}Pu and ^{237}Np. Information available at present indicates that the most suitable processing method for the large scale production of ^{238}Pu is anion exchange in a nitrate medium. (139 references). (J.G.B.)

26334 THE VALUATION OF BY-PRODUCTS FROM THE TREATMENT OF NUCLEAR FUELS: NUCLIDES RECOVERED FROM IRRADIATED FUELS. Lopez-Menchero, E. Bull. Belgicatom, 13: No. 3/4, 19-25(Oct.-Dec. 1968). (In French).

The nuclides that can be recovered from irradiated fuel elements and their principal characteristics are discussed. Economic stimulants for their recovery are evaluated. The types of procedures needed for recovery of inert gases, metallic fission products, and transuranides are indicated. The price and cost production of the most valuable nuclides are considered. The analysis suggests development of procedures integrated for the processing of the fuel elements and the recovery of desired elements. (J.S.R.)

26335 CHEMICAL REPROCESSING OF IRRADIATED FUELS IN THE NUCLEAR FUEL CYCLE. Detilleux, E. (Univ., Liege). Bull. Belgicatom, 13: No. 3/4, 33-9(Oct.-Dec. 1968). (In French).

An outline is given of the chemical reprocessing of irradiated fuels. The steps in the fuel cycle before the reprocessing described are reduction of the reactivity and modification of the crystalline structure of the matrix. The steps in the reprocessing are given. (J.S.R.)

26336 SEPARATION OF RADIONUCLIDES BY ZONES OF INORGANIC ION EXCHANGERS ON FILTER-PAPER STRIPS. Weisz, H.; Klockow, D.; Fritsche, U. (Univ., Freiburg i. B.). Z. Anal. Chem., 244: 289-94(1969). (In German).

A number of various inorganic ion exchangers were prepared in the form of narrow zones on paper strips. Their exchange behavior against some radioisotopes was studied in different aqueous solutions using a technique similar to ascending paper chromatography. From the results of these experiments possibilities for separating mixtures of nuclides were derived with the aid of one, two, or three zones of exchangers on the paper strips. A qualitative scheme could be worked out for separating the mixture of the fission products ^{137}Cs/^{137m}Ba, ^{90}Sr/^{90}Y, ^{106}Ru/^{106}Rh, ^{144}Ce/^{144}Pr, and ^{95}Zr/^{95}Nb. (auth)

26337 ISOTOPE EXCHANGE PROCESS. Roth, Etienne; LeFrancois, Bernard (to Houilleres du Bassin du Nord et du Pas-De-Calais). British Patent 1,149,729. Apr. 23, 1969. Priority date July 27, 1966, France.

A process for isotopic exchange between NH_3 synthesis gases containing D and liquid NH_3 comprises enriching the liquid NH_3 with D in two isotope exchangers in series. The liquid NH_3 is contacted in the first exchanger with the synthesis gases and in the second exchanger with the product of cracking some of the enriched NH_3 from the second exchanger. The temperature in both exchangers is such that the reaction of NH_3 with HD proceeds toward the formation of NH_2D and H_2. After cracking part of the enriched liquid NH_3 from the second exchanger, the vaporized portion is returned to the second exchanger. The synthesis gases coming from the first exchanger are passed to a synthesis unit from which part of the produced liquid NH_3 is supplied to the first exchanger, and the synthesis gases coming from the second exchanger, together with fresh synthesis gases, are passed to the first exchanger. Deuterated NH_3 lean in D is removed from the synthesis reactor and deuterated NH_3 rich in D is removed from between the second exchanger and the cracking reactor. The second exchanger is maintained at a pressure that is at the most equal to the pressure of the gases leaving the cracking reactor. (B.L.M.)

26338 SEPARATION OF CHELATES OF RARE EARTH COMPOUNDS AND PROMETHIUM BY FRACTIONAL SUBLIMATION. Eisentraut, Kent J.; Sievers, Robert E. U. S. Patent 3,429,904. Feb. 25, 1969. Filed Nov. 4, 1966.

A method is described for the preparation of the chelates of rare earths and promethium with 2,2,6,6-tetramethyl-3,5-heptanedione. Apparatus and method are also described for separation of the chelates by fractional sublimation depending on the differences in volatility of the chelates. After separation, the chelates are easily converted to the oxides. (B.L.M.)

26339 IMPACT OF LARGE-SCALE PLANTS ON FUEL REPROCESSING. Rodger, Walton A.; Reese, Stanton L. (Nuclear Safety Associates, Rockville, Md.). Reactor Fuel-Process. Technol., 12: No. 1, 27-40(Winter 1968–69).

The impact of a new generation of larger reprocessing plants on fuel cycle costs, their radiological impact on the environment, and the technical, engineering, and operational problems associated with this scale-up are discussed. The impact of the West Valley plant on its successor plants is considered. Effects of plant scale on costs are evaluated. It is estimated that the capital cost for a 1500 metric ton plant would be $78 million. (M.C.G.)

26340 SEPARATION OF RARE EARTH ELEMENTS BY POTASSIUM SULFATE FRACTIONAL PRECIPITATION METHOD.

Nishikawa, Yasuharu; Kiraki, Keizo (Kinki Univ., Osaka). Kinki Daigaku Genshiryoku Kenkyusho Nenpo, No. 6, 9-14(1967). (In Japanese).

The fractional separation of rare earth elements, yttrium, and scandium by potassium sulfate was described. Cerium subgroup elements were almost completely precipitated as potassium sulfate double salt. By this method, a rapid separation of yttrium subgroup from cerium subgroup elements was performed. (NSA of Japan)

26341 SCANDIUM GENERATOR. Mirza, M. Y.; Aziz, A. (Pakistan Inst. of Nuclear Science and Tech., Islamabad). Radiochim. Acta, 11: 43-4(Mar. 1969).

A method is recommended for the radiochemical separation of scandium from titanium that can be successfully applied for the routine milking of the 3.9-hr nuclide ^{44}Sc from its 47-yr half-life parent ^{44}Ti. The method utilizes the extraction of scandium from an aqueous solution buffered at pH 1.8 to 4.5, using 1-phenyl-3-methyl-4-caprylpyrazolone-5 (PMCY) in methyl isobutyl ketone (MIBK) as extracting agent. A good decontamination factor of 10^6 and more than 90% added scandium activities can be recovered in less than 10 minutes. (auth)

26342 N-BASES AS SYNERGIZING AGENTS IN THE SOLVENT EXTRACTION OF ^{64}Cu AND ^{65}Zn BY THENOYLTRIFLUOROACETONE. Driver, R.; Walker, W. R. (Univ. of Newcastle, Australia). Aust. J. Chem., 21: 3065-8(Dec. 1968).

Synergistic extraction in systems such as M/HTTA/Sy (M = Cu^{2+} or Zn^{2+}; HTTA = thenoyltrifluoroacetone; Sy = an organophosphorus compound, e.g., tri-n-octylphosphine oxide, quinoline, isoquinoline, pyridine) was investigated by determining the extraction of ^{64}Cu and ^{65}Zn by HTTA and a series of N-bases. The greater extraction in the ^{64}Cu system compared to that of ^{65}Zn was probably due to the stability of ternary complexes. Stabilities of ternary Cu(II) complexes such as $Cu(TTA)_2Sy$ (Sy = organophosphorus compound) are much greater than for the corresponding Zn complexes. The order 4-methylpyridine > 3-methylpyridine > pyridine was found as expected from the basic strength of the bases. For the same reason, 2-methylpyridine should have also extracted better than pyridine; however, steric hindrance by the methyl group explained its poor coordinating ability and hence the anomalously low extraction. Isoquinoline extracted better than quinoline, probably because of its greater basicity and less steric hindrance. The superior extraction of isoquinoline to that of the picolines that was found was not expected from their relative basic strengths, but could be explained in terms of water solubilities. The high extraction shown by 4-ethylpyridine, even greater than for isoquinoline, was surprising. The former, although water-soluble, apparently forms an adduct that is soluble in hexane. (BBB)

26343 USE OF TERTIARY AROMATIC AMINES IN THE EXTRACTION OF URANIUM FROM NEUTRAL AND ACIDIC MEDIA. Gagliardi, E.; Herold, G. (Univ., Graz). Anal. Chim. Acta, 45: 289-96(Apr. 1969). (In German).

Tertiary aromatic amines behave in different ways in the extraction of uranium(VI). In neutral media all the amines tested show more or less high extractabilities. In acidic media, turbidities are obtained in some cases, and reasonable extractions in other cases. The more distant the nitrogen from the amine nucleus, or the more ramified the chain, the better is the extraction. Out of 21 amines examined, 3-(dimethylamino)methylindole in chloroform proved to be the best extracting agent. (auth)

26344 PROCESS AND APPARATUS FOR DECANNING FUEL ELEMENTS. Faugeras, P.; Stratakis, J. (to Commissariat a l'Energie Atomique). Canadian Patent 807,595. Mar. 4, 1969. Priority date Jan. 20, 1965, France.

The process consists of dissolving the fuel element cans in a continuous stream of acid etching solution and then rinsing the decanned elements prior to their removal from the vessel by means of a continuous circulation of neutral solution. The canned fuel elements are circulated in co-current flow with the acid etching solution while the decanned elements circulate in countercurrent flow to the neutral rinsing solution. The flow mechanics and adjustment of speeds are described. (F.S.A.)

26345 STUDIES OF ACTINIUM(III) IN VARIOUS SOLUTIONS. II. DISTRIBUTION BEHAVIOR OF LANTHANUM(III) AND ACTINIUM(III) IN SOME CHELATE EXTRACTION SYSTEMS. Sekine, Tatsuya; Foike, Yasuaki; Hasegawa, Yuko (Tokyo Univ.). Bull. Chem. Soc. Jap., 42: 432-6(Feb. 1969).

Distribution behavior of lanthanum(III) and actinum(III) at tracer concentrations was studied in metal chelate extraction systems where the organic phase was chloroform containing dibutylphosphate, thenoyltrifluoroacetone (TTA), β-isopropyltropolone, or 5,7-dichloroxine. The separation factors for this pair of ions by extraction with these four chelating ligands were determined. The distribution behavior was also studied in adduct chelate extraction systems where the organic phase was carbon tetrachloride containing mixed ligands, TTA-tributylphosphate (TBP) or TTA-methyl isobutyl ketone (MIBK). The adduct formation constants for actinium(III)-tris-TTA chelate with these neutral ligands were determined. Results were compared with previous results on the distribution behavior of other trivalent actinide and lanthanide ions in these systems. It was concluded that the separation of lanthanum-actinium was somewhat different from the separation of europium-americium in the same chelate extraction systems. The stabilities of the first adducts with TBP or MIKB of actinium TTA chelate were smaller than those of americium TTA chelate, but the stabilities of the second adducts showed just the reverse order. This tendency in adduct formation is the same as that observed among the lanthanum and europium adduct TTA chelates in previous work. Use of the TTA-TBP mixture was recommended for the extraction of lanthanum(III) or actinium(III) at tracer concentrations based on the fact that the use of these mixed ligands resulted in much better recovery of material and better reproducibility of results than a single chelating ligand. (auth)

26346 POWDERED ION EXCHANGE IN NUCLEAR CYCLES. Ryan, L. F.; Brown, R. M. (Graver Water Conditioning Co., Union, N. J.). Proc. Amer. Power Conf., 30: 903-16(1969).

From 30th Annual American Power Conference, Chicago, Ill. See CONF-680418.

The suitability of powdered ion-exchange resins for the various water treatment services in nuclear cycles is discussed. Areas requiring the ion-exchange process in PWR, HTGR, and BWR are considered. Improved water quality and lower operating costs are shown to result from use of powdered resins. Test work was carried out using actual condensate from nuclear cycles. (M.C.G.)

26347 D_2O SUPPLY ACCORDING TO THE H_2/NH_3 DUAL TEMPERATURE PROCESS. Becker, E. W.; Lang, G.; Schindewolf, U. (Univ., Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.). Atomwirt., Atomtech., 14: 257-60(May 1969). (In German).

Studies were made of the optimal construction and product costs of a H_2/NH_3 dual-temperature arrangement. Technological calculations for a 100-ton installation are presented. (M.C.G.)

26348 SEPARATION OF SCANDIUM, YTTRIUM, THE RARE EARTHS, THORIUM, AND URANIUM(VI) BY THIN-LAYER CHROMATOGRAPHY. Kozima, Masuo; Oguma, Koichi. Tokyo Kogyo Shikensho Hokoku, 64: 133-5(Mar. 1969). (In Japanese).

The chromatographic behavior of scandium, yttrium, the rare earths, thorium, and uranium(VI) in dioxane–hydrochloric acid and dioxane–nitric acid media on a thin layer of cellulose was investigated. The following separations are possible: scandium–yttrium–lanthanum, scandium–samarium–thorium, scandium–lanthanum–lutetium, yttrium–lanthanum–thorium, and lutetium–thorium–uranium (VI) with dioxane–12$\underline{M}$ hydrochloric acid (7:3 vol/vol) and scandium–samarium–thorium, scandium–yttrium–uranium (VI), lutetium–thorium, and scandium–lanthanum–thorium with dioxane–14$\underline{M}$ nitric acid (7:3 vol/vol). A single chromatographic spray (Ārsenazo-III) was used for the detection of all the metal ions studied. (auth)

26349 STUDY OF STRIPPING URANIUM COMPLEX FROM AN AMINE EXTRACT WITH AQUEOUS SALT SOLUTIONS. Jickling, R. S.; Diez, G.; Van Cleave, A. B.; DeCoursey, W. J. (Univ. of Saskatchewan, Saskatoon). Can. J. Chem. Eng., 46: 53-6(Feb. 1968).

The organic phase produced by extraction of a uranium leach liquor with Amberlite LA-2 in kerosene was stripped of uranium in laboratory tests with solutions of NaCl and H_2SO_4 or solutions of Na_2SO_4. It was found that NaCl–H_2SO_4 stripping reduced considerably the effectiveness of the solvent for subsequent extraction, whereas Na_2SO_4 stripped the uranium content without any deleterious effect. Optimum Na_2SO_4 concentration and pH for stripping were determined. Phase separation time and entrainment losses appear satisfactory. (auth) (CANADA)

26350 SYNERGISTIC EFFECT IN SOLVENT EXTRACTION OF SCANDIUM β-DIKETONE TOPO SYSTEM. Shigematsu, Tsunenobu; Wake, Ryousuke; Honjyo, Takaharu; Matsui, Masakazu (Kyoto Univ.). Bull. Inst. Chem. Res., Kyoto Univ., 46: 269-74 (Nov. 1968).

The terminal group effect of β-diketones on the synergism was studied in scandium–β-diketone–TOPO system. Eight β-diketones, acetylacetone (AA), diisobutyrylmethane (DIBM), benzoylacetone (BzA), dibenzoylmethane (DBM), trifluoroacetylacetone (TAA), benzoyltrifluoroacetone (BFA), thenoyltrifluoroacetone (TTA) and furoyltrifluoroacetone (FTA) were employed as the chelating agent. The scandium β-diketonates reacted with trioctylphosphine oxide

(TOPO) to form the ScR_3L type adduct, and the stability constant of the adducts increased in the following order: AA $\lesssim$ DIBM < BzA < DBM $\lesssim$ TFA $\ll$ FTA < TTA < BFA. The tendency may be attributed to the strong electron withdrawal of a trifluoromethyl group and the resonance effect of a phenyl group, which increase the residual coordination power of the metal ion. The steric effect of the terminal group on the synergism was not recognizable. (auth)

EARTH SCIENCES

Geology and Hydrology

Refer also to abstracts 26179, 26254, 26392, 26436, and 28655.

26351 (AEC-tr-7042) MEANS AND FINDINGS OF STUDY OF RADON RADIOACTIVITY IN NATURAL WATERS. Jurain, G. Translated from Geochim. Cosmochim. Acta, 20: 51-82(1960). 51p. Dep. CFSTI.

A field method for the determination of the radon content of natural waters is described, and the results obtained in the course of two surveys in different regions of France were analyzed using statistical methods. It appears that the radon contents are distributed lognormally in a given geological formation; the determination of radon in waters is capable of development into a geochemical prospecting technique; and the radon contents of waters are very often greater than those encountered in biological systems. (auth)

26352 ^{90}Sr-CONTAMINATION OF POLISH SOILS. PART II. THE ^{90}Sr-CONTAMINATION OF SOILS OF SOUTHERN AND CENTRAL POLAND IN 1963. Litynski, T.; Domnicz, A. (Coll. of Agriculture, Krakow). Rocz. Glebozn., 18: 43-55(1967). (In Polish).

After two years of systematic investigations on the soil contamination in Central and Southern Poland by ^{90}Sr it was possible to ascertain that the average soil contamination by ^{90}Sr on the areas investigated in 1963 amounted to 23.2 ± 6.7 mCi/km^2. This did not differ significantly from the contamination observed in 1962, which was 21.3 ± 8.3 mCi/km^2. There is a direct relation between the degree of soil contamination and the annual total precipitation as well as the altitude above sea-level. The inversely proportional relation between the ^{90}Sr content in soil and the latter's content of silt and clay is conditioned by the radiochemical yield of the applied method, the yield being nonuniform for the particular soils. There is an inversely proportional relation between the ^{90}Sr content in soil and its pH, and the results are valid only for the fraction of soil ^{90}Sr which is extractable in 10% hydrochloric acid. (auth) (NSA of Poland)

26353 ^{90}Sr DISTRIBUTION IN THE PROFILES OF SOME ARABLE SOILS OF LOWER SILESIA. Malysowa, E.; Bors, J.; Szerszen, L. (Coll. of Agriculture, Wroclaw). Rocz. Glebozn., 18: 33-41(1967). (In Polish).

Dispersal of ^{90}Sr was tested in samples of ten soil profiles, taken in 1964 from fields near Wroclaw. They included podzols, pseudopodzols, brown and black earths of various mechanical compositions, and boggy turf soil. ^{90}Sr content was determined with the yttrium method of Reissig, exchangeable Ca of Jensen and Henrikson, and a complete pedologic analysis performed with standard methods. It was found that downward eluviation of ^{90}Sr in the profile is inconsiderable and is observed in light soils only. The distribution of ^{90}Sr in the profiles of the tested arable soils is primarily caused by the mechanical soil cultivation. (auth) (NSA of Poland)

26354 ACCUMULATION OF NITRATE IN FRESH SOILS AFTER GAMMA IRRADIATION. Cawse, P. A.; White, T. (Atomic Energy Research Establishment, Wantage, Eng.). J. Agr. Sci., 72: 331-3(1969).

Increases in nitrate were found in eight out of ten soils irradiated over the range 0.25 to 2.5 Mrad, with maximum accumulation between 0.25 to 0.75 Mrad. Oxidation of ammonium added to normal soils was poor at low pH, and showed a highly significant correlation with nitrate produced after 0.25 Mrad. It is suggested that radiation-released ammonium is less limiting to nitrate formation than the original population or activity of nitrifying organisms, which are favored by alkaline conditions. (auth)

26355 ABUNDANCES OF K, Rb, Sr, AND Sr ISOTOPES IN ULTRAMAFIC ROCKS AND MINERALS FROM WESTERN NORTH CAROLINA. Stueber, Alan M. (Carnegie Institution of Washington, D. C.). Geochim. Cosmochim. Acta, 33: 543-53(May 1969).

Detailed study of the strontium isotopic composition of closely associated alpine-type ultramafic intrusions in western North Carolina revealed variable but high ^{87}Sr/^{86}Sr ratios, similar to those found in previous reconnaissance studies. Because of the relatively wide variations in ^{87}Sr/^{86}Sr ratios on a local scale and the lack of isochron relationships, it seems that radiogenic strontium may have been introduced into the ultramafic intrusions, in most cases without significant alteration of the primary silicate minerals. The intrusion of pegmatites into the ultramafics and country rock about 350 Myr ago is a likely source of secondary radiogenic strontium. Investigation of the distribution of K, Rb and Sr within the mineral phases of ultramafic rocks indicated that the concentration of strontium is critically controlled by the amount of diopside present. The absolute abundance levels of all three elements are generally higher in minerals separated from a basaltic ultramafic nodule than in those separated from alpine-type intrusions. The K/Rb ratios of the alpine-type ultramafic rocks bear no systematic relationship to K content. If each ultramafic sample is considered as a separate system, however, the K/Rb ratios increase with increasing K content and in the order olivine to enstatite to diopside, in every case. This relationship was not found for minerals separated from the basalt nodule. (auth)

26356 CHEMICAL STUDY OF THE HOT SPRING WATERS IN KOREA. III. DETERMINATION OF RADON. Park, Kyu Chag (Dong A Univ., Korea). Onsen Kagaku, 19: 49-53(Sept. 1968). (In Japanese).

Determination of radon in 9 samples of hot spring waters and 18 samples of underground water in Korea, collected from Oct. 31, 1967 to Feb. 15, 1968, was carried out at the Korean Army Test & Research Laboratory. Radon contents are 3.6 to 36.2 maché in the hot spring waters in Korea and 0 to 24.2 maché in the underground waters in the vicinity of each hot spring. Toksan, Onyang, Suanbo, Paekam, Tongnae, and Haeundae Springs are classified as a radioactive spring group. Underground waters of high Rn contents like those of Onyang A, Yusung A and B, Baikam A, Magumsan B, and Tongnai A and B, are to be used for medical treatment. Radon contents in the hot spring waters of the middle hot spring group increased in proportion to their Sb contents. Radon contents in the hot spring waters of the southern hot spring group decrease inversely to their potassium content. In the case of the middle hot spring group, the K content was almost constant, but the Rn content varied. It was found that the behavior of Rn was not the same as that of K. (NSA of Japan)

26357 GEOLOGY PLAYS AN IMPORTANT ROLE IN RADIOACTIVE WASTE MANAGEMENT. Reichert, S. O. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Contract AT(07-2)-1. Mining Eng., 20: 98-103(Sept. 1968).

The program for management of gaseous, liquid, and solid wastes at the Savannah River Plant is discussed. Knowledge of the characteristics of the wastes and the environment are necessary for safe ground disposal. Favorable environmental parameters include a deep water table with long flow path and low gradient to the stream and soil with high ion exchange capacity and moderate to low permeability. Reduction of tritium is achieved by ground water dilution. Reduction of ^{90}Sr is achieved largely by ground water dilution but partially by soil adsorption. All other radionuclides are readily adsorbed by the soil. Amounts of liquid waste which can be released are limited because of ^{90}Sr migration. Leaching of ^{90}Sr from buried solid waste is negligible. (F.S.)

26358 A METHOD FOR EVALUATION OF GAMMA MEASUREMENTS BY MEANS OF THE ZRA 1 AUTOMATIC DIGITAL COMPUTER. Lampenscherf, W.; Steinbrecher, Dieter (Technische Hochschule, Magdeburg, Ger.). Z. Angew. Geol., 14: 93-5(Feb. 1968). (In German).

Examples of computer analysis of the spectrum of soil core samples were described and discussed. The flow chart of the computer program used was presented, and the iteration procedure was explained. The results of the computer analysis agreed closely with results from manual analysis of the data. The advantage of the machine computation procedure was that the vertical resolution of activity in the cores, which was from 1.5 to 2 hr long, was superior to analysis by other methods. In addition, the time required for the complete analysis of a sample was only 3 min. (BBB)

26359 GEOKHIMIYA STABIL'NYKH IZOTOPOV UGLERODA. (Geochemistry of Stable Carbon Isotopes). Galimov, E. M. Moscow, Izdatel'stvo Nedra, 1968. 224p.

The isotopic composition of carbon can be used as an indicator of peculiarities in the genesis and the geological history of ores and minerals. The main questions of the geochemistry of stable isotopes of carbon were examined along with the physical-chemical and biological processes of isotopic fractionation under natural conditions. Information is given concerning the relative contents of ^{12}C and ^{13}C in living organisms and organic materials buried underground, minerals and ores, fuels, and gases. The distribution of isotopes in cosmic substances is described and the problem of cosmic and geological evolutions of carbon and its isotopes considered. Special attention was directed to the geological interpretation of rules for distribution of carbon isotopes in natural objects. (tr-auth)

26360 THE RADIUM (^{226}Ra) DISTRIBUTION IN HOT SPRINGS AND THE FORMATION MECHANISM OF RADIOACTIVE SPRINGS. II. Iwasaki, Iwaji (Tokyo Inst. of Tech.). Onsen Kogakkaishi, 6: 112-14(Dec. 1968). (In Japanese).

The quality of hot springs is not constant, always undergoing changes. The radium content of hot springs also varies similarly. The jetting points of hot springs may be close to one another but this may not necessarily be so under the earth's surface. The following properties of hot springs are described: the hot-spring temperature and the radium content; the ionic-hydrogen concentration and the radium content; the evaporation residue and the radium content; the chemical composition and the radium content; the variation in the radium content. (NSA of Japan)

26361 WATER. Radiol. Health Data Rep., 9: 168-71(Mar. 1968).

Data for the radioactivity in raw surface waters for September 1967, are tabulated for 36 rivers in the U.S. The average alpha radioactivity and the average beta radioactivity are given for both suspended and dissolved samples. (D.H.M.)

26362 COMPARATIVE STUDIES OF THE SORPTION AND DESORPTION OF VARIOUS RADIONUCLIDES BY SHOAL GROUNDS. Baranova, D. D. pp 219-26 of Voprosy Biookeanografii. Materialy II Mezhdunarodnogo Okeanograficheskogo Kongressa, 30 Maya-9 Iyunya 1966 g, Moskva. Kiev, Izdatel'stvo Naukova Dumka, 1967. (In Russian).

From 2nd International Oceanographic Congress, Moscow, USSR. See CONF-660574.

Experiments were carried out on the sorption and desorption of ^{90}Sr, ^{91}Y, ^{95}Zr, ^{106}Ru, ^{137}Cs, and ^{144}Ce, by soils from the Black Sea littoral, in order to study the migration of these radionuclides. The sorption tests were carried out in closed, cone-shaped flasks containing 3.5 g of soil and 50 ml of filtered seawater; the radionuclides were introduced together in indicator amounts. After shaking the flasks and letting the contents settle for 12 hrs, the dried soil and the water samples were subjected to radiometric measurements. The results indicated that the silts possess great sorption capacity with respect to ^{137}Cs and ^{144}Ce. The silt samples were fractionated in order to determine the portion playing the most important role in the process and the uptake coefficient of these nuclides. Aleurolite and phaseoline-type shoal silts were found to possess great sorption capacity toward all of the radionuclides in spite of differences of physical and mechanical properties. These silts had similar uptake coefficients for each of the isotopes, attributable to the <90 μ diameter particle size fraction. Cesium-137 was most easily retained by the silts; it was desorbed by seawater and 2$\underline{N}$ hydrochloric solution. The desorption of ^{91}Y, ^{144}Ce by the same acid from the silts increased with their carbonate-bearing soil content. The silts may be considered as a sink for ^{91}Y, ^{137}Cs, and ^{144}Ce in the sea. The action with respect to ^{90}Sr may be neglected. (TTT)

Meteorology

Refer also to abstracts 26766 and 28530.

26363 (CEA-R-3701) EVALUATION OF ATMOSPHERIC CONTAMINATION BY PLUTONIUM WITH DISCRIMINATION OF THE NATURAL ACTIVITY. Clech, Albert; Prevot, Rene (Commissariat a l'Energie Atomique, La Hague (France)). Mar, 1969. 18p. (In French). Dep.

The application of aerosol sampling methods using two filters of different stopping powers, for the discrimination of natural activity was evaluated. The experimental results were used to establish charts which make it possible to evaluate atmospheric contamination by plutonium, and to calculate the margin of error. (auth)

26364 (CEA-R-3777) SPECTROMETRIC CHARACTERISTICS OF THE γ EMISSION OF FISSION PRODUCTS: ANALYSIS OF IRRADIATED URANIUM WITH A "GERMANIUM-LITHIUM" DETECTOR. Chevillon-Pitollat, Pierre-Louis; Pannetier, Raymond (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Mar. 1969. 46p. (In French). Dep.

In order to study the gamma spectra of atmospheric aerosol samples obtained with Ge-Li detectors, the spectrometric characteristics of fission product gamma emission had first to be specified by analyzing the evolution through time of the spectra of irradiated uranium. (auth)

26365 (LA-4133) BETA RADIOACTIVITY IN ENVIRONMENTAL AIR AND PRECIPITATION AT LOS ALAMOS, NEW MEXICO, FOR 1968. Kennedy, W. R.; Aeby, Jack W. (Los Alamos Scientific Lab., N. Mex.). Feb. 1969. Contract W-7405-eng-36. 13p. Dep. CFSTI.

Beta activity of particulate matter in both air and precipitation for 1968 at Los Alamos, New Mexico, is reported. The declining activities for January through April seem to be residual fallout from the 1966 foreign nuclear weapons tests, and the December high seems due to late 1967 tests. The May through September increases reflect the increasing rainfall of that period. (auth)

26366 (SC-RR-68-559) THE DETERMINATION OF THE QUANTITY OF RADIOACTIVITY CONTAINED IN A GASEOUS EFFLUENT AT THE NEVADA TEST SITE USING GAMMA DOSE-RATE MEASUREMENTS. Matthews, P. O. (Sandia Labs., Livermore, Calif.). Dec. 1968. 33p. Dep. CFSTI.

Methods are presented which may be used to obtain a quantitative estimate of radioactive effluent activity using gamma dose-rate measurements. A method is discussed by which estimates may be made of activities of noble gases released through filtered exhaust systems. In addition, the activities, in terms of Curies per kiloton fission yield from ^{235}U thermal fission, for selected isotopes of the xenon, krypton, and iodine nuclides are plotted versus time after fission. (auth)

26367 ^{85}Kr IN THE ATMOSPHERE. Csongor, Eva (Nuclear Research Inst., Debrecen, Hungary). Fiz. Szemle, 19: 33-5(Feb. 1969). (In Hungarian).

The atmosphere contains a large amount of radioactive materials as the result of atmospheric weapons testing. The rare gases resulting from fission do not form compounds and do not become attached to dust particles, as do other fission products. Most of the 16 radioactive isotopes of Kr have short half-lives, except ^{85}Kr which has a half-life of 10.76 years. This caused the accumulation of ^{85}Kr in the atmosphere during the past decades. The ^{85}Kr content of krypton samples was determined on the basis of the β radiation with an E_{max} = 0.67 MeV. Analysis of samples collected during Aug. 1954 and Dec. 1966 revealed that the ^{85}Kr content keeps increasing continuously with a doubling time of 3 to 4 years. Assuming that the ^{85}Kr yield from the fission of ^{235}U by thermal neutrons is 0.273, the calculated 125 kg of ^{85}Kr required 120 tons of ^{235}U-equivalent of fissionable material, corresponding to a fission energy of 2400 Mtons of TNT. From the known atmospheric weapons testing it may be concluded that only a small portion of the ^{85}Kr found is due to weapons tests; the rest is coming from reactor fuel reprocessing plants. The current concentration does not represent a radiobiological hazard but the krypton should not be used for filling ionization chambers because its activity exceeds the permissible background level. Xenon still may be used for this purpose. (TTT)

26368 GEOCHEMICAL FRACTIONATION OF INDUCED RADIONUCLIDES IN FRESH NUCLEAR DEBRIS THROUGH THE ATMOSPHERE: ^{239}Np AND ^{60}Co. Sotobayashi, Takeshi; Suzuki, Toshio; Koyama, Seitaro (Univ. of Niigata, Japan). Bull. Chem. Soc. Jap., 42: 716-20(Mar. 1969).

The atmospheric fractionation of induced radionuclides is discussed in some detail on the basis of results obtained by making a radiochemical analysis of fresh nuclear debris originating from recent Chinese nuclear test explosions. Among fresh nuclear debris particles collected at Niigata about 4000 km downwind from the Chinese test site, the trend for the enrichment of ^{239}Np was somewhat modified as compared with that derived from an averaged sample collected by a large-scale and high-altitude sampling procedure; more ^{239}Np was present in smaller-size fallout particles. Furthermore, it was found, in rainwater samples collected after the third Chinese nuclear explosion, that the atomic ratio at time-zero of ^{60}Co/^{95}Zr increased with a decrease in the ^{95}Zr-concentration in rain and vice versa. This suggests that the atmospheric fractionation of ^{60}Co-rich particles from ^{95}Zr-rich ones takes place during the travel of atomic clouds around the world. (auth)

26369 AEROSOL RESEARCH: AEC SPONSORED AEROSOL WORK IN THE OUTDOORS. Engelmann, Rudolf J. (Atomic Energy Commission, Washington, D. C.). J. Air Pollut. Contr. Ass., 18: 656-7(Oct. 1968).

Current outdoor or field aerosol work sponsored by the AEC, mainly studies of meteorological processes which utilize aerosols, is described. These processes include diffusion and transport, dry deposition, and precipitation scavenging. Deposition of radioiodine on pasture grasses and its uptake by cattle are under study at the National Reactor Testing Station, Idaho. Attempts to identify SO_2 from a chosen stack by means of the ratio of ^{32}S to ^{34}S in the plume are being made. These isotopes occur naturally in fuels, and fuels from some oil fields have an abnormal abundance of one or the other isotope. Since precipitation accounts for most of the deposition of radioactive aerosols, the AEC has an active program in the washout and rainout of gases and aerosols. When possible, naturally occurring aerosols are followed. For example, the cosmic ray-produced radionuclides ^{7}Be, ^{38}Cl, ^{39}Cl, ^{24}Na, and others are quickly attached to the natural aerosol, and are used to date and follow the motion of the natural aerosol. (BBB)

26370 PILOT EXPERIMENT USING INDIUM AS TRACER IN A CONVECTIVE STORM. Dingle, A. Nelson; Gatz, Donald F.; Winchester, John W. (Univ. of Michigan, Ann Arbor). J. Appl. Meteorol., 8: 236-40(Apr. 1969).

In the study of circulations and rain scavenging processes in severe convective storms, a pilot experiment using indium as tracer was conducted. A total of 200 g of indium was released over a period of 21 min into the updraft feeding a relatively small convective system. The tracer was released by means of pyrotechnic flares from an airplane flying at about 3200 ft altitude. The rainfall from the system was sampled at the ground by means of an array of samplers placed and recovered by two mobile units. Results of the sample analysis compared against analyses of untagged rain samples and reagent backgrounds of indium indicates the presence of tracer indium in a reasonable distribution pattern. (auth)

26371 DETECTION OF INDIUM AS AN ATMOSPHERIC TRACER BY NEUTRON ACTIVATION. Gatz, Donald F.; Dingle, A. Nelson; Winchester, John W. (Univ. of Michigan, Ann Arbor). J. Appl. Meteorol., 8: 229-35(Apr. 1969).

In a test of the use of indium as a particulate atmospheric tracer, both tagged and untagged rain showers were sampled at ground level in Oklahoma during May 1967. In 29 samples of untagged rain 6 ± 3 nanograms of In per liter were found, indicating a natural background somewhat above the reagent blank of about 2 ng liter^{-1}. After aircraft injection at cloud base of 200 g of indium, as finely divided particles from pyrotechnic flares, a maximum of 40 ng liter^{-1} was found in the rain, and a pattern of localization of the tracer indium was revealed in an array of 14 samplers spaced over 11 km. The procedure for analysis began in the field with (1) addition of HCl to the polyethylene samplers before rain was collected to ensure solubility of the tracer, (2) filtration to remove suspended solids, (3) addition of lanthanum internal standard, Fe^{+++}, and NH_3 to each 1-liter sample to precipitate In and La with $Fe(OH)_3$, and (4) membrane filtration of the $Fe(OH)_3$. At The University of Michigan the procedure continued with (5) reactor neutron activation of the filters, (6) separation of In from La by isopropyl ether extraction from HBr solution, and (7) assay of In and La radioactivities by β and γ counting, respectively. The sensitivity of the method is determined by the natural background of the indium found. (auth)

26372 OTHER DATA. Radiol. Health Data Rep., 9: 184-94(Mar. 1968).

Summaries of data from the environmental radioactivity monitoring reports from Argonne National Laboratory, Atomics International, Feed Materials Production Center, and the National Reactor Testing Station are given for January through June 1967. Data on reported nuclear detonations during February 1968, are also presented. (D.H.M.)

26373 AIR AND DEPOSITION. Radiol. Health Data Rep., 9: 172-83(Mar. 1968).

Surveillance data for November 1967, on radioactivity in airborne particulates and precipitation are reported from the programs of the U. S. Public Health Service, the Canadian Department of National Health and Welfare, the Mexican Commission of Nuclear Energy, and the Pan American Health Organization. Data on the ^{90}Sr fallout in the U. S., and in other countries of North and South America for January through June 1967, are tabulated. Results of the radiochemical analysis of precipitation samples at 3 U. S. sites for January through June 1967, for ^{55}Fe, ^{90}Sr, ^{144}Ce, ^{238}Pu, and ^{239}Pu–^{240}Pu are reported. (D.H.M.)

26374 INTERHEMISPHERIC TRANSPORT OF ATMOSPHERIC FISSION DEBRIS FROM FRENCH NUCLEAR TESTS. Palmer, B. D. (Henderson State Coll., Arkadelphia, Ark.). Science, 164: 951-2(May 23, 1969).

Radioactive iodine-131 (half-life, 8.06 days) and barium-140 (half-life, 12.8 days), released into the atmosphere (21°S, 137°W) by the French nuclear tests conducted during the period August 24 to September 8, 1968, have been observed in rainfall at Arkadelphia, Arkansas (34°N, 97°W). The maximum time required for the transport of the debris from a mid-southern to a mid-northern latitude appears to be about 3 weeks. (auth)

Mineralogy and Exploration

Refer also to abstract 26474.

26375 (NP-17855) URANIUM PRODUCTION AND SHORT TERM DEMAND. (European Nuclear Energy Agency, Paris (France). International Atomic Energy Agency, Vienna (Austria)). Jan. 1969. 29p.

Present and future production of uranium in Argentina, Australia, Canada, France, Portugal, South Africa, Spain, Sweden, and the U.S. are briefly reviewed. Possible increased production capability is discussed in the context of prior exploration and proven reserves, followed by mining and ore processing to yield ore concentrates greater than 60% U_3O_8. The evolution of world uranium production since the beginning of industrial extraction is reviewed and the probable demand for the next ten years evaluated. (F.S.)

26376 AN ASSESSMENT OF THE URANIUM POTENTIAL OF ITALY'S MAIN LIGNITE DEPOSITS. Giannotti, G. P.; Mittempergher, M.; Nascimben, P. (CNEN, Rome). Com. Naz. Energ. Nucl., Notiz., 14: No. 12, 39-48(Dec. 1968). (In Italian).

A survey was conducted of several Italian lignite mining areas, with a view to determining the content and distribution of uranium in lignite. To this end, geological and radiometric field surveys were supplemented by 548 tests for U_3O_8 in lignite and lignite ashes. Excluding the scattered lignite occurrences, the study of which was conditioned by requirements of basic methodological research, it was found that some 12,000 tons of U_3O_8 are contained in the lignite of some major areas. Some of 90% of this potential is located in the Sulcis area lignite, where the U_3O_8 content (in lignite and ashes) is substantially higher than that found in other major lignite deposits (Mercure, Bastardo, Castelnuovo dei Sabbioni-Allori). Because of the low contents of U_3O_8, none of Italy's lignites can be regarded as a uranium-bearing mineral. Furthermore, in the present state of technological progress, uranium extraction from the ashes as a by-product of lignite burning is out of the question, because of the heavy chemical processing costs and the limited quantities of ashes available for treatment. (auth)

26377 URANIUM OF POCOS DE CALDAS. Cunha, Octacilio. Eng. Mineracao Met., 46: 251-4(Dec. 1967). (In Portuguese).

The economic feasibility of processing the uranium ores of Pocos de Caldas is analyzed. (J.S.R.)

26378 ATOMIC MINERALS IN INDIA. Nucl. News, 12: No. 4, 23-4(Apr. 1969).

The exploration and production of Be, Nb, Ta, Th, Ti, U, Zr and the rare earths by the Indian Atomic Energy Commission are reviewed. The distribution and development patterns of thorium and uranium minerals are described including uranium in Bihar, Udaipur, Udaisagar and the Himalayas. India has the largest established thorium reserves in the world. Thorium is found in granites, meta-sediments and sedimentary rocks of Peninsular India. The nuclear fuel complex at Hyderabad, including uranium oxide, zirconium, and ceramic fuel plants, is briefly described. (F.S.)

26379 THE URANIUM INDUSTRY: ITS HISTORY, TECHNOLOGY, AND PROSPECTS. Griffith, J. W. Mineral Report 12. Ottawa, Department of Energy, Mines, and Resources, 1967. 335p. $10.00.

The development which brought about the postwar rise and decline in the Canadian uranium industry is described. Characteristics, distribution and uses are detailed as well as production, exports, prices, ore reserves and the structure, financing and control of the industry. World resources and production statistics in most of the principal producing countries are included. Forecasts on future world needs, the general outlook and Canada's position in what is expected to be a highly competitive market are also outlined. The operations of 28 mining operations past and present are reviewed including costs, production, reserves and other pertinent information. (F.S.A.)

26380 MINERAL INDUSTRY AND ECONOMY IN 1967: MINERAL REVIEWS IN DETAIL: URANIUM. Williams, R. M. (Dept. of Energy, Mines, and Resources, Ottawa). Can. Mining J., 89: 129-33(Feb. 1969).

Events in the uranium industry during 1967 provided convincing evidence that a commercial market for uranium has come to stay. Orders for the construction of nuclear power stations around the world were made at an increasing rate, necessitating upward revisions of nuclear capacity forecasts made only one year ago. Exploratory effort, including that by foreign interests, has become intense and new mine development a reality. Production is surveyed and sales commitments to 1980 are given. Resource and product capability together with nuclear developments including the approval of two additional 540 MW(e) units at the Pickering site are described. An optimistic outlook for the future of the industry is forecast. (F.S.A.)

Oceanography

Refer also to abstract 26715.

26381 (BARC-376) ABSORPTION OF TRACE ELEMENTS BY NEAR SHORE SEA-BED SEDIMENTS. Ganapathy, S.; Pillai, K. C.; Ganguly, A. K. (Bhabha Atomic Research Centre, Bombay (India)). 1968. 113p. Dep.

Research on the parameters responsible for the accumulation of radioisotopes in different environments and its implications in the neighborhood of nuclear installations are reported. Samples of shore sediment collected from the area near the CIRUS reactor stilling pool were chemically analyzed. In the analysis, the carbonate and organic contents were obtained. The sediment and the clay fractions separated from the sediment were analyzed for Al, Ca, Cr, Cu, Fe, K, Mg, Mn, Na, PO_4, Rb, SiO_2, Sr, and Zn. Particle size distribution and base exchange capacities were determined. The effects of time of contact and the volume of leaching solution were studied. Results obtained on ^{45}Ca, ^{60}Co, ^{137}Cs, ^{42}K, ^{54}Mn, ^{32}P, ^{85}Sr, ^{89}Sr, and ^{65}Zn pickup by sediments and composite fission product solutions are given. Mechanisms of sediment pickup of radioactive elements are discussed on the basis of the basic principles of soil chemistry. Results are evaluated in relation to the distribution of radioactivity in seawater and sediments. The significance of pickup in the decontamination of coastal waters is reviewed. (F.S.)

26382 (NYO-2174-95) GENERAL SUMMARY OF PROGRESS, 1968-1969. (Woods Hole Oceanographic Institution, Mass.). May 1969. Contract AT(30-1)-2174. 34p.. Dep. CFSTI.

Measurements and interpretation of radiochemical blanks were conducted. Subsurface ocean samples were analyzed for ^{90}Sr and ^{137}Cs. Tables are presented of ^{90}Sr in Atlantic Ocean samples from 1963 to 1968. Data for ^{137}Cs content are also included. The relative abundance of foraminifera, radiolaria, and pteropods in open-ocean plankton is summarized from sampling various areas of the Atlantic Ocean. Studies of stable element concentrations in biogenic sediments and marine organisms in the marine environment continued. (J.C.W.)

26383 RHENIUM: ITS CONCENTRATION IN PACIFIC OCEAN SURFACE WATERS. Scadden, E. M. (Naval Radiological Defense Lab., San Francisco). Geochim. Cosmochim. Acta, 33: 633-7(May 1969).

The average Re concentration in four widely spaced Pacific Ocean surface seawater samples was found to be 0.0084 μg/l ± 17%. The amount of Re found in (or on) a brown kelp plant (Macrocystisintegrifolia) was 0.022 μg/g freeze-dried plant. The Re in seawater was found to exist as an extractable species. (auth)

Seismology

Refer to abstracts 26423 and 26604.

ENGINEERING

Nuclear Explosions

Refer also to abstracts 26329, 26372, and 26766.

26384 (AD-677403) THE MASS CONTOUR RATIO FOR FALLOUT AND FALLOUT SPECIFIC ACTIVITY FOR SHOT SMALL BOY. Final Report. Miller, Carl F.; Yu, Oliver S. (Stanford Research Inst., Menlo Park, Calif.). Dec. 1967. Contract N00228-67-C-1143. 43p. (USNRDL-TRC-68-15). CFSTI.

Data on the fallout specific activity from Shot Small Boy were analyzed. The specific activity for particles of about 50 to 200 microns in diameter was approximately constant, and for particles over 2,000 microns was approximately inversely proportional to particle diameter. An exponential function was fitted to the data to represent the dependence of specific activity on particle diameter in shifting from volume to surface area modes of incorporation of specific activity. (auth) (USGRDR)

26385 (AD-681379) ACOUSTIC-GRAVITY WAVES FROM AN ENERGY SOURCE AT THE GROUND IN AN ISOTHERMAL ATMOSPHERE. Cole, J. D.; Greifinger, C. (RAND Corp., Santa Monica, Calif.). Dec. 1968. Contract DAHC15-67-C-0141. 37p. (RM-5828-ARPA/AFT). CFSTI.

An analysis is given by two different methods—stationary phase and kinematic theory—of the pressure pulse generated by a nuclear explosion near the ground in an isothermal atmosphere. The shape of the signal is shown as a function of time at several distances from the source for a fixed altitude, and at several altitudes for a fixed lateral distance. The first signal to arrive at any location is a high-frequency acoustic wave, followed by a low-frequency acoustic-gravity wave. The onset of the latter is marked by a sharp front, or caustic. At any instant after the arrival of the caustic there are three principal frequency components at any location, the lowest of which becomes dominant as time progresses. The qualitative features of the flow, as well as the exact location of the caustic, can be obtained from kinematic theory. (USGRDR)

26386 (CONF-690312-5) PLOWSHARE STUDIES AT PRNC. Gomberg, Henry J. (Puerto Rico Nuclear Center, Mayaguez). [1967]. 12p. Dep. CFSTI.

From Symposium on Education for the Peaceful Uses of Nuclear Explosives, Tucson, Ariz.

The Project Plowshare studies performed at the Puerto Rico Nuclear Center are described. Activities included are workshops and personnel training. Research included a study on the effects of temperature and heating times on the leaching of a Cu chalcopyrite type ore in sulfuric acid solutions and the development of prediction equations from cratering models. Work in progress is described and long-range plans given. (J.C.W.)

26387 (CONF-690312-6) CONFERENCE SUMMARY. Gomberg, Henry J. (Puerto Rico Nuclear Center, Mayaguez). [nd]. 11p. Dep. CFSTI.

From Symposium on Education for the Peaceful Uses of Nuclear Explosives, Tucson, Ariz.

A summary is given on the philosophy of the Plowshare project from impressions conceived from the conference reports. Education for the peaceful uses of nuclear explosives was discussed. (J.C.W.)

26388 (NVO-99-20) STRUCTURAL CONDITION SURVEY: MOVEMENT OF BUILDING ELEMENT CRACKS IN SIX MERCURY, NEVADA STRUCTURES. Nelson, William H. (Blume (John A.) and Associates Research Div., San Francisco, Calif.). Dec. 1967. Contract AT(26-1)-99. 53p. Dep. CFSTI.

Structures in Mercury, Nevada, within the Atomic Energy Commission's Nevada Test Site, are continually subjected to ground motion generated by underground nuclear events (detonations) at the Site. To determine what effect this ground motion might have on the structures, a number of buildings at Mercury have been instrumented and monitored since December 1965. The results of studies on six of these buildings, from December 1965 through January 1967 are presented. The principal conclusion—based on analyses of recorded data on crack movements, temperatures, relative humidity, and wind and sun conditions—is that movements of cracks during periods which included event-generated ground motion were exceeded by movements of cracks during the intervening periods which did not include strong motion from underground nuclear events. On this basis, the conclusion is that damage was not caused to Mercury buildings by event ground motion during this period of time. (auth)

26389 (PNE-G-31) PRELIMINARY OBSERVATIONS OF THE POST-SHOT GEOLOGIC EFFECTS OF THE GASBUGGY NUCLEAR STIMULATION, NORTHEAST SAN JUAN BASIN, NEW MEXICO. Martin, William B. (El Paso Natural Gas Co., Tex.). Feb. 20, 1969. 32p. (CONF-690207-1). Dep. CFSTI.

From Meeting of the Rocky Mountain Section of the AAPG, Albuquerque, N. Mex.

Evidence obtained in the Gasbuggy experiment is indicative of shattering, or shear and compressional failure, in the Fruitland coal section a radial distance of approximately 550 feet from the detonation point, in the Pictured Cliffs sandstone a radial distance greater than 300 feet and in the Upper Lewis—to the depth drilled—a radial distance of some 500 feet. Less data, related to the extent and degree of fracturing beyond the zone of intense deformation, are available at the present time. Casing parting to a distance of 650 feet, casing constriction to a radial distance of 780 feet and lowering of the Ojo Alamo water head at that radial distance from the detonation are offered as evidence for fracturing to a distance of 800 ± feet. Net radial displacements, in the ARPA well, of slightly less than one inch at distances of 1,600 to 1,750 feet may be indicative of fracturing or cracking to distances beyond 800 feet. It is hypothesized that beyond the zone of severe rock deformation; within the "fracture" zone, effective permeability will be created by nuclear stimulation. In effect, permeability can be created as a result of the detonation by opening preexisting zones of weakness and enlarging indigenous fracture and joint surfaces and both minor and major bedding planes. Evidence to support this statement relates to the lowering of the fluid column in the 10-36 well and flow of gas from the normally barren Lewis strata. (auth)

26390 (PNE-G-41) PLANNING AND PROGRAM DIRECTIVE. Project GASBUGGY. (Nevada Operations Office (AEC), Las Vegas). Aug. 1967. 146p. Dep. CFSTI.

The Project Gasbuggy organization, major assignments of responsibilities, project planning schedules, required procedures for project management, reports, controls, and general planning guidance are set forth for the project. (J.C.W.)

26391 (UCRL-71624) GASBUGGY EXPERIMENT. Holzer, Fred (California Univ., Livermore. Lawrence Radiation Lab.). Mar. 10, 1969. 35p. (CONF-690312-3; PNE-G-43). Dep. CFSTI.

From Symposium on Education for the Peaceful Uses of Nuclear Explosives, Tucson, Ariz.

The planning, execution, and interpretation of nuclear explosions for peaceful purposes require people with training and experience in a variety of disciplines, as well as with a broad and mature outlook. This training and experience was tested in the Gasbuggy experiment, not only in accomplishing the various tasks but also in overcoming a number of unexpected difficulties. Results from postshot drilling, gas production, and radiochemical and chemical analyses indicate a cavity radius of 80 ft, a chimney height of 335 ft, and failure in the rock matrix to between 400 and 500 ft. Offsets along geologic weaknesses have been observed 750 ft from the detonation center. Concentrations of tritium and krypton in samples taken from the chimney gas are about 10 and 2 $\mu Ci/ft^3$, respectively, and vary with the rate of gas production from the chimney. Results so far, while encouraging, emphasize a number of unanswered questions in the use of nuclear explosions for gas reservoir stimulation. (auth)

26392 (USGS-474-16) GEOLOGY AND HYDROLOGY OF THE PROJECT RULISON EXPLORATORY HOLE, GARFIELD COUNTY, COLORADO. (Geological Survey, Denver, Colo.). Apr. 4, 1969. Contract AT(29-2)-474. 19p. (PNE-R-2). Dep. CFSTI.

Hydrologic tests on the Rulison exploratory hole indicated that little or no water occurs in the Ohio Creek Conglomerate and Mesaverde Group which are the stratigraphic units most likely to yield water to the hole. Six depth intervals, beginning at 6,129 feet and ending at 8,018 feet, were tested. Pressures recorded during the testing of the individual zones indicated little or no fluid entry while the test tool was open. (auth)

26393 (VUF-3013) FREE-FIELD PARTICLE MOTION FROM A NUCLEAR EXPLOSION IN SALT. PART II. Project 12.11 of PROJECT DRIBBLE, SALMON EVENT. Eisler, J. D.; Hoffman, H. V. (Stanford Research Inst., Menlo Park, Calif.). June 1966. 159p. Dep. CFSTI.

On Salmon, a 5-kt tamped underground nuclear explosion in salt, acceleration, velocity, displacement, and strain with vertical component gages at several depths above the shot were measured with multicomponent gages at shot level and on the surface. A large amount of sporadic electrical noise was noted on the record traces. The records were edited to remove the noise and corrected for base line shifts. Displacement was obtained by integration of acceleration and velocity records. Because of apparent misorientation of the gages at shot level, the radial and transverse components of ground motion at that depth were determined on the assumption of radial motion of first arrivals. These results show the transverse motion to be small. Because of the general scatter of the velocity data, no conclusion can be reached regarding asymmetry of ground motion. Second arrivals at subsurface transverse gages do not correspond to shear motion arrivals. Additional pulses on subsurface gages were attributed to reflections from the flanks of the salt dome. Subsurface motion data agreed satisfactorily with that recorded previously. Scaled Salmon subsurface peak velocity and displacement agreed adequately with those for Gnome, a 3-kt tamped nuclear shot in salt. Scaled subsurface peak acceleration however was considerably greater than that derived for Gnome. This disparity may possibly be a result of the limited high frequency capability of the recording systems used on Gnome. Surface motions on Salmon and Gnome were correlated by including the effects of ray path geometry and free-field ground motion. (auth)

26394 TRAVEL TIMES AND AMPLITUDES OF THE SALMON NUCLEAR EXPLOSION. Lehmann, I. (Columbia Univ., Palisades, N. Y.). Bull. Seismol. Soc. Amer., 59: 959-66(Apr. 1969).

Travel times and amplitudes of the P_n and P waves generated by the nuclear explosion Salmon fired in the State of Mississippi are studied. To the west the P_n waves are found to be cut off at a distance of about 1800 km, where they are about to enter the mountainous region. An increase of P amplitude with distance goes to confirm that the P velocity increases with depth and to indicate that the time-curve is a continuous, bending curve. (auth)

26395 TRANSIENT FLOW CHARACTERISTICS OF LOW PERMEABILITY GAS RESERVOIRS AND IMPROVEMENTS OF DELIVERABILITY BY NUCLEAR EXPLOSION. Eilerts, C. Kenneth; Sumner, Eudora F. (Bureau of Mines, Bartlesville, Okla.). Soc. Petrol. Eng. J., 8: 209-23(Sept. 1968).

A program for computing the transient radial flow of natural gas, taking into account significant variable properties of the fluid and of the porous medium, was used in an investigation of flow characteristics of formations for which the permeability-thickness product kh is 1 to 100 md-ft. A graphic summary of the results obtained may be used with well flow-test data to estimate kh for the formation in which the well is completed. Assuming that a nuclear explosion in a gas-containing formation would create a rubble-filled chimney with a diameter of 170 ft and fissures radiating from the chimney wall out to a distance of 255 ft, formation pressure gradients were computed for the recovery of gas with a well drilled into the chimney. These computations for 640- and 160-acre spacing indicate that diminution of the radius segment $r_e - r_f$ over which flow occurs in unaltered formation provides for markedly greater ultimate recovery of gas in place than is possible with conventional well completions. A formation drilled with conventional wells 1.0 mile apart must have a productivity product of kh = 197 md-ft to deliver for 20 years 1.0 MMscf/D of gas into a pipeline operated at 300 psi. Aided by nuclear stimulation, one well can meet the same performance requirements with a kh of only 49 md-ft for the native formation. With a spacing of 160 acres and nuclear stimulation, kh need be only 9 md-ft. (auth)

26396 BIBLIOGRAPHY ON UNDERGROUND NUCLEAR EXPLOSIONS (1968). Perilli, Maria Luisa. Com. Naz. Energ. Nucl., Notiz., 15: No. 4, 97-103(Apr. 1969). (In Italian).

A listing of 159 articles on underground nuclear explosions is presented including descriptions of explosions, containment of radioactivity, and applications for civil engineering and mineralogy. (F.S.)

Facilities and Equipment

Refer also to abstracts 26452, 26466, 26470, 26495, 26996, 27005, 27049, 27050, 27163, 27529, 27541, 27570, 27588, 27589, 28073–28075, and 28450.

26397 (AERE-Trans-1091) PRESSURISED CARBON DIOXIDE TEST LOOPS. Gutner, G. Translated by T. O. Lazarides (Atomic Energy Research Establishment, Harwell, Eng.), from Bull. Cent. Rech. Essais Chatou, No. 14, 3-16(1965). 17p. Dep. CFSTI. UK 2s. 6d.

The main pressurized carbon dioxide test loops built at the Chatou Research and Testing Center for studying the head loss and heat transfer characteristics of various component parts of a gas-cooled reactor channel are described. (auth)

26398 (AHSB(S)R-162) SURVEY OF DEFECTS IN PRESSURE VESSELS BUILT TO HIGH STANDARDS OF CONSTRUCTION AND ITS RELEVANCE TO NUCLEAR PRIMARY CIRCUIT ENVELOPES. Phillips, C. A. G.; Warwick, R. G. (United Kingdom Atomic Energy Authority, Risley (England). Authority Health and Safety Branch). 1968. 36p. Dep. CFSTI. UK 6s.

The first stage is reported of a survey of defects in Class I-constructed pressure vessels. The implications of the results are analyzed and their relevance to nuclear primary circuit envelopes assessed. A review of defined normal operational failures in British and American reactor primary circuit envelopes is included for comparison with relevant incidents in conventional vessels. (auth)

26399 (BARC-351) APPLICATION OF THEORY OF FILTRATION ON A SPECIFIC QUALITY OF ASBESTOS. Khan, A. A.; Amalraj, R. V.; Ramachandran, S. (Bhabha Atomic Research Centre, Bombay (India)). 1968. 30p. Dep.

Next to glass fibre, asbestos is the most suitable material for the production of high efficiency air filters for meeting the ever increasing demands of defense, nuclear plants, electronics and other industries. The pressure drop characteristics of one of the typical Indian asbestos fiber, which was found to be a good filter material, are studied. The behavior of this material with reference to the widely accepted theories of resistance across the fibrous beds is discussed in the light of experimental data. (auth)

26400 (BMwF-FBK-68-47) STUDY FOR A RADIATION CHEMISTRY RESEARCH CENTRE. Schneider, C.; Ley, G. (Cologne Univ. (West Germany)). Dec. 1968. 22p. (In German). Dep.

A study was prepared for a radiation chemistry research center which permits the development of radiation chemical processes from laboratory-scale to pilot plant-scale research as well as the training of scientific personnel. The overall planning which includes the technical complex, buildings for administration, laboratories, workshop, and store is discussed. Different design possibilities for the ^{60}Co source are given and radiation protection is taken into account. The costs for construction, radiation source, and equipment and the yearly operating budget are estimated. (auth)

26401 (BMwF-FBK-68-57) SPECIAL EQUIPMENT OF THE INSTITUTE FOR RADIOCHEMISTRY OF "TECHNISCHE HOCHSCHULE MUENCHEN." PART I. "HOT LABORATORY." Lorenzen, K. (Technische Hochschule, Munich (West Germany). Institut fuer Radiochemie). Dec. 1968. 23p. (In German). Dep.

The Institute for Radiochemistry at the "Technische Hochschule München" was equipped with a "hot laboratory," constructed durint 1962 to 1965, for working with highly radioactive materials. Subsequently, special equipment for investigating these materials was installed. The design and construction of the hot laboratory, including the special equipment are discussed. (auth)

26402 (BNL-12625) CONTROLLED REMOVAL OF SPHERES FROM A GEOMETRICALLY ORDERED PACKED BED BY SURFACE FLUIDIZATION. Susskind, Herbert; Odette, Robert; Becker, Walter (Brookhaven National Lab., Upton, N. Y.). [nd]. 30p. (CONF-681212-2). Dep. CFSTI.

From 61st Annual American Institute of Chemical Engineers Conference, Los Angeles, Calif.

The removal of individual layers of balls from the surface of an ordered packed bed without disturbing the remaining packing was investigated. The modified jet pumping procedure could be used in the countercurrent fuel movement in the Ordered Bed Fast Reactor, as well as for the selective unpacking of beds of spheres in other industrial applications. Liquid jets entering two opposite sides of a square cross-section column through rectangular nozzles above the surface of the packed bed produced drag forces on the balls at a critical flow rate that were strong enough to entrain them and carry them out with the outgoing liquid. The distance of bed penetration increased with this critical flow rate. Such variables as liquid flow, ball density and diameter, nozzle velocity and inclination, and column size were investigated, and a mechanism for this model was postulated. The data could be correlated by the expression $R = 2.63 + 0.755 \ln X$, where R is a dimensionless parameter for ball removal and X is a measure of the useful jet work. (auth)

26403 (COO-286) COMPILATION OF INFORMATION FOR EXISTING LARGE SODIUM VALVES. Burton, S. F. (Chicago Operations Office (AEC), Ill. Reactor Engineering Div.). June 1966. 17p. Dep. CFSTI.

A data compilation is presented on relatively large (6 to 16 in.) sodium valves used in the EBR-II, Enrico Fermi Atomic Power

Plant, Hallam Nuclear Power Facility, Large Component Test Loop, Ohio Injector Co., Sodium Components Test Installation, and the Sodium Reactor Experiment. Information is included on engineering drawings, procurement specifications, costs, excluding R and D, operator type and cost, operating conditions and a discussion of performance for blocking, check, flow control, and throttling valves. (F.S.)

26404 (EGG-1183-2203) EXPERIMENTAL STUDY OF A LARGE-AREA ECOLOGICAL IRRADIATOR. Quam, W. M.; Wilde, W. O. (EG and G, Inc., Santa Barbara, Calif.). Feb. 1969. Contract AT(29-1)-1183. 26p. Dep. CFSTI.

A special source-shield arrangement was used to experimentally investigate differences noted between measured and calculated dose-rate distributions for an irradiation system designed for use in ecological studies of small animal populations. The effects of angular aperture, shield radius, and radiation leakage on dose rate were measured and compared to calculated values. The results indicate that radiation leakage was the principal cause of the discrepancy between measured and calculated dose rates. The experimental data also show that the close-in dose rate is a sensitive function of the lower shield radius and the angular aperture, whereas the far-field dose-rate is more sensitive to the lower shield radius than to the other shield parameters. (auth)

26405 (GA-8292) ENGINEERING METHOD FOR THE EVALUATION OF STEAM GENERATOR VIBRATIONS. Kellar, William J. (Gulf General Atomic, Inc., San Diego, Calif.). Feb. 14, 1969. Contract AT(04-3)-633. 10p. Dep. CFSTI.

An engineering method for evaluating vibration effects on heat exchanger tubing linearizes the vibration equation by substituting a magnification factor for the damping term and recognizing that the aerodynamic driving force is Reynolds number-dependent. Feedback between tube and fluid stream is neglected for small amplitudes. Magnification factors are used that are determined from component vibration tests and lift coefficients from flow tests. Scaled models of tube arrays were also used to determine lift coefficients. A test program was completed for the development of a device to reduce tube damage from long term low level vibrations using a tube support method. This method provides tube support and wear protection. Long duration testing (10^8 cycles) showed no tube surface damage to either ferritic or nickel alloy tubes. (F.S.)

26406 (PR/OP-58) ELASTIC STRESSES IN PULSED REACTOR FUEL RODS. Ward, J. L.; Warnke, E. G. ([Atomic Weapons Research Establishment, Aldermaston (England)]). Jan. 26, 1966. 22p. Dep.

The dynamic behavior of fuel rods in a pulsed reactor was investigated by considering a distributed mass model. The peak stresses obtained were compared to those obtained using a lumped mass model. (F.S.)

26407 (SC-M-69-129) DESIGN REQUIREMENTS FOR LAMINAR AIRFLOW CLEAN ROOMS AND DEVICES. Lindell, K. F.; Whitfield, W. J.; Garst, D. M. (Sandia Labs., Albuquerque, N. Mex.). May 1969. 55p. Dep. CFSTI.

The basic concept of laminar airflow and the control of airborne contamination by this method are explained. Basic design criteria essential for the maximum performance of the various types of laminar airflow facilities are described and illustrated. An appendix provides a list of items useful in preparing a comprehensive clean room specification. (auth)

26408 (TID-4100(Suppl.51)) ENGINEERING MATERIALS LIST. Kelly, Robert C. (ed.) (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). May 1969. 36p. DTIE Free.

Twenty-two packages of engineering drawings and specifications are presented. Packages of drawings are included on gamma ion chambers, evacuated alpha chambers, multi unit pulse generators, low-level alpha monitors, RC shaped pulse generators, trigger generators, constant current battery dischargers, composite image projectors, 12 inch fast gate valves, double thermowells, shipping containers, radiation immunology incubators, extended range gaps, film-image-synchronized cameras, aural response transducers, dry hole charger shipping casks, 60 kV spark gaps, sub-master trigger gaps, liquid resistors, multiplier for particle identifiers, ultrasonic sphere inspection fixtures, and variable pulse delays. A subject index is included. (R.C.K.)

26409 (WARD-3762-1) LARGE SODIUM PUMP DESIGN STUDY. PHASE I. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). Mar. 1968. Contract AT(30-1)-3762. 719p. Dep. CFSTI.

Design and parametric information on large mechanical centrifugal sodium pumps for LMFBR service are presented. This information includes the effects of systems requirements on pump design, and presents design analyses of pump hydraulics, drives, shaft seals, bearings, materials and other mechanical components. For a set of reference design conditions, two pump concepts are recommended; one for a piped reactor and the other for a sea-of-sodium reactor. (auth)

26410 IMPROVEMENTS IN OR RELATING TO FLUIDISED BED APPARATUS. Lanaspeze, Pierre; Tannenberger, Helmut (to United Kingdom Atomic Energy Authority). British Patent 1,150,317. Apr. 30, 1969. Filed Feb. 18, 1966.

Reference is made to fluidized bed apparatus adapted for the high temperature treatment of particulate material. This apparatus usually comprises a refractory walled furnace, usually tubular, having a fluidizing gas injection nozzle in the base, together with a suitable means for heating the fluidized particles. Due to movement of particles in the furnace, unless some means are provided for heating the interior of the furnace uniformly it is inevitable that the particles will be cycled and recycled through zones of different temperatures, with resulting temperature stressing of the particles. This problem has particular relevance to apparatus for the production of coated nuclear fuel particles, where temperature cycling may lead to cracking or other flaws in the coatings. Apparatus is described which incorporates a sleeve of refractory heat insulating material supporting the furnace wall adjacent to the gas inlets and enclosing the supply routes for the gases, and serving to inhibit thermal leakage from the furnace. Means may be provided within the sleeve for cooling the process gas, and the gases may enter the furnace through a Venturi passage. (UK)

26411 IRRADIATION DEVICE WITH BREMSSTRAHLUNG. Imai, Toshikazu (to Chiyoda Safety Appliance Co., Ltd.). Japanese Patent 1968-29038. Nov. 28, 1968. Filed Apr. 11, 1966.

A bremsstrahlung irradiation device is described in which the strength of emitted bremsstrahlung can be adjusted easily. The device consists of a one-end closed shielding cylinder with a suitable lining; a piston and a piston rod in the cylinder, the rod penetrating through the closed end of the cylinder; an electron source attached on the "open-end" side of the piston; and a bremsstrahlung irradiator set at the open end of the cylinder. By moving the piston with the source axially through the cylinder, the intensity of bremsstrahlung can be adjusted. (NSA of Japan)

26412 STUDIES ON THE DESIGN CRITERIA FOR THE RADIATION PROTECTION IN ATOMIC INSTALLATIONS. Fujii, Shoichi; Sekine, Takashi (Building Research Inst., Tokyo). Kenchiku Kenkyusho Nenpo (Tokyo), Fiscal 1967, 403-9(Sept. 1968). (In Japanese).

Studies were carried out on the shielding effects of a concrete labyrinth for gamma radiation, and on the efficiency and dust particle distribution of domestic filters. It was bound that close to the radiation source, there is a large difference in dosage between the higher and lower position in the labyrinth, but farther away this difference is reduced, and with domestic filters, 99.9% of the particles of size diameter 0.3 μ could be removed and nearly 100% of those larger than 0.4 μ. (NSA of Japan)

26413 METERING AND PROPORTIONING PUMPS IN NUCLEAR ENGINEERING. Sauerbaum, E. (Bran and Luebbe, Hamburg). Kerntechnik, 11: 169-70(Mar. 1969). (In German and English).

Nuclear engineering involving the handling of radioactive liquids frequently requires metering and proportioning pumps which ensure reliable protection against radioactivity and which have zero or controlled leakage. Four types of pumpheads and their sealing devices designed to meet these specific needs are described briefly. They include: a controlled-leakage plunger-type pumphead; a plunger-type metering pump with gland sealing bellows; diaphragm-metering pumphead; and double diaphragm metering pumphead. (L.C.L.)

26414 METHOD OF AND APPARATUS FOR DETECTING INHOMOGENEITIES IN METAL WIRES WHICH HAVE BEEN CAUSED BY RADIATION. Meier, Rolf (to European Atomic Energy Community). British Patent 1,150,707. Apr. 30, 1969. Priority date Dec. 1, 1965, Germany.

A method and equipment for detecting radiation induced inhomogeneities in metal wires, such as thermocouple wires are described. The irradiated wire is joined to a similar but nonirradiated wire of the same length and the two pieces of wire are fed into the oven at a constant speed. The thermovoltage produced between the free ends is evaluated as an indication or measurement of the inhomogeneities. The apparatus consists of an oven containing a winding-on reel, means for winding, two winding-off reels outside the oven a voltmeter, and means for making an electric connection between the free ends of the wires and the voltmeter. (F.S.)

26415 SHIELD FOR RADIOGRAPHY. Tokunaga, Tadashi (to Japan Steel and Tube Corp.). Japanese Patent 1968-22800. Sept. 25, 1968. Filed Mar. 22, 1966.

A shield is described that has the following advantages: easy radiography regardless of the shape of the subjects; minimization of the shield thickness; and close contact with the subject. The shield is obtained by tightly coiling wire with a polygonal cross section. (NSA of Japan)

26416 STRESSES IN COMPACT END CLOSURES FOR CYLINDRICAL PRESSURE VESSELS. Preater, R. W. T. (City Univ., London). J. Strain Anal., 4: 57-64(Jan. 1969).

Three different assumptions are made for the behavior of the junction between the cylindrical shell and the end closure. Comparisons of analytical and experimental results show that the inclusion of a rigid annular ring beam at the junction of the cylinder and the closure best represents the shell behavior for a ratio of cylinder mean radius to thickness of 3 to 7, and enables prediction of an optimum vessel configuration to be made. Experimental verification of this optimum design confirms the predictions. (The term rigid is used in this context to refer to a ring beam for which deformations of the cross-section are ignored but rigid body motion is permitted.) (auth)

26417 U. S. ATOMIC ENERGY COMMISSION FOOD RADIATION PROGRAM. Shea, K. G. (Atomic Energy Commission, Washington, D. C.). Chem. Eng. Progr., 64: Symp. Ser. No. 83, 3-15(1968).

From American Inst. of Chemical Engineers Meeting, Atlantic City. See CONF-660903.

A discussion and summary of recent events in the U. S. Atomic Energy Commission-sponsored food irradiation program are presented. The prime objective of the program, directed toward civilian consumption, is to develop radiation-treated fish, fruit, and related products with longer shelf life. The status of various foods and of the supporting irradiators is discussed and illustrated. (auth)

26418 MACHINE IRRADIATION SOURCES AND IRRADIATION TECHNOLOGY. Brynjolfsson, Ari (Army Natick Labs., Mass.). Chem. Eng. Progr., 64: Symp. Ser. No. 83, 71-86(1968).

From American Inst. of Chemical Engineers Meeting, Atlantic City. See CONF-660903.

Electron accelerators are the principal nonisotopic sources of ionizing radiation. These machines will play a key role in the radiation processing of foods. Applications where the processing rate, load factor, and the delivered energy favor the use of machines are reviewed. Available and applicable machines, the technology and cost comparisons are presented. (auth)

26419 INDUSTRIAL USE OF ^{60}Co FOR STERILIZATION OF MEDICAL PRODUCTS. Stonehill, Albert A. (Ethicon, Inc., Somerville, N. J.). Chem. Eng. Progr., 64: Symp. Ser. No. 83, 120-2(1968).

From American Inst. of Chemical Engineers Symposium, Detroit. See CONF-661201.

The first commercial large-scale cobalt-60 irradiator for the sterilization of medical products in the United States was put into operation in August 1964. The facility was designed and installed by Atomic Energy of Canada, Ltd. A description of the facility, its operating experience, and efficiency and sterilization results are reported. The advantages of sterilization by cobalt-60 are discussed. (auth)

26420 OPTIMUM DESIGN OF RADIATION CHEMICAL REACTORS. Harmer, David E. (Dow Chemical Co., Midland, Mich.); Wilkinson, Bruce W. Chem. Eng. Progr., 64: Symp. Ser. No. 83, 111-19(1968).

From American Inst. of Chemical Engineers Symposium, Detroit. See CONF-661201.

The design of radiation chemical reactors in which the initiator is gamma or x rays has been analyzed to determine the best combination of source and reactor geometry. Mathematical derivations and sample data are given for both spherical and cylindrical reactors, designed for chemical reactions in which the reaction rate is proportional to the radiation intensity raised to a fractional exponent. For both reactor geometries, the source requirement for a given reactor capacity is materially reduced by incorporating a hollow core around the radiation source. This core lowers the radiation intensity in the reaction zone and permits the more efficient utilization of the radiation. With a cylindrical reactor, increase of the length-to-diameter ratio further decreases the source requirements and it would appear that optimum ratios of length-to-diameter and of core-to-outer reactor radii exist for each system. (auth)

26421 STEADY-STATE THERMAL STRESSES IN THE VESSEL OF A PRESSURIZED WATER REACTOR. Kolonits, F. (Office for Power Station and Network Design, Budapest). Acta Tech. Acad. Sci. Hung., 62: 351-74(1968).

The present work analyzes the stresses in the pressure vessel of a pressurized water reactor under steady-state operating conditions, with some simplifying assumptions. Since the radiation load is the heaviest at about the midpoint of the active zone, considerations will be restricted to that section of the vessel. The problem is divided into three interrelated parts: the examination of radiation absorption in the wall, or evaluation of the heat sources; the temperature response to these heat sources; thermal stresses arising from differences in the temperature. The correctness of the approximations is examined and calculations are presented concerning the vessel of the reactor of type "Voroniesh." The error in the temperature is 0.022%, in the reduced stress (referring to its maximum value at the outer fiber) is 0.056%. This latter deviates toward safety. The error caused by the approximation of the cylindrical wall by a plane is also favorable. The temperatures at the inner surface are in good agreement from a practical viewpoint. The error at the outer fiber is 0.293% (less than the estimated value). The preliminary evaluation of stresses was based on gradients which are higher everywhere in case of the plane approximation. In the position of highest loading the stresses are actually higher in the case of the plane; this is the case along the inner half of the wall, but outside it is the reverse. However, the differences are always less than 1%, i.e., practical approximation. (BBB)

26422 CONDITIONS FOR DEVELOPMENT OF NUCLEAR POWER IN CZECHOSLOVAKIA. Sevcik, Augustin (Power Maintenance Service, Prague). Energetika, 18: 520-2(Oct.-Nov. 1968). (In Czech).

The requirements of a nuclear energy industry include high-quality metals and equipment and a good supply of uranium. Czechoslovakia is the classical home of uranium, and therefore has natural uranium, but it must import enriched material. Capital investment is needed. Various types of reactors and fuels are discussed, together with power needs by 1985. It is concluded that the time has arrived for wide industrial construction of nuclear electric power plants in Czechoslovakia. (TTT)

26423 SIMPLIFICATION OF THE WORK FOR EARTHQUAKE-PROOF DESIGN BY STANDARDIZING PIPING SYSTEMS. Okada, Akira. Haikan Gijutsu, 11: 136-42(Jan. 1969). (In Japanese).

In nuclear power stations and reprocessing facilities for spent fuel, consideration for safety must be given to prevent contamination by the diffusion of radioactive substances. The earthquake-proof design is one of those safety measures. At present, the fundamental concept in the earthquake-proof design for mechanical structures is to consider the structure rigid. For multiple-pipe systems involving several fundamental shapes of piping, modules are selected and their dimensions are determined so that their natural frequencies are sufficiently higher than the distinguished frequencies at the fixing points. The piping system is constructed by fixing the limits between the fundamental shapes. With this method, the whole piping system is designed to be rigid and nonresonant in case of earthquake. Therefore, the design work is greatly simplified. Four fundamental shapes were selected, and each shape has length and bent angles within certain ranges, and includes two or less bends. The calculation of their natural frequencies is explained. (NSA of Japan)

26424 DEVICE FOR DRIVING A CONTROL ROD. Mikami, Takao (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1968-31279. Dec. 18, 1968. Filed Feb. 22, 1965.

A method is described in which the control rod drive mechanism can be cooled and radioactive material at the reactor vessel bottom can be removed. The control rod driving mechanism consists of: a bottom-end closed cylinder protruding downward from the reactor vessel bottom; an upper-end closed hollow piston rod to which a control rod is connected on the closed top end; a hollow piston formed at the open lower end of the piston rod (both the piston rod and piston are contained in the protruding cylinder, the piston rod running through the vessel-bottom opening); pipes connecting into the cylinder for supplying the hydraulic power; a narrow hole penetrating through the vessel bottom wall within the enclosure by the protruding cylinder; and a narrow hole penetrating through the piston. Water is run through the holes to cool the mechanism and to remove radioactive material deposited at the vessel bottom. (NSA of Japan)

26425 FUTURE DEVELOPMENT OF CZECHOSLOVAKIAN ELECTRICAL NETWORKS AND THE RESULTING NEED FOR DEVELOPMENT OF NUCLEAR ENERGY. Kartak, Milan (Power Maintenance Service, Prague). Energetika, 18: 522-4 (Oct.-Nov. 1968). (In Czech).

An annual industrial growth rate of 5% is predicted for Czechoslovakia, and an increase in the number of electrical power stations is expected. A graph of the electric power used in the past shows a similar rate increase in Czechoslovakia and other countries. Charts show production of power in various ways from 1965 to 2000 and the geographical location of large power needs in 1970 and 1980. It is concluded that the development of nuclear power will depend not only on the need for power but also on the technology and economics of nuclear power production. (TTT)

26426 PRESTRESSED CONCRETE IN BUILDING OF NUCLEAR POWER PLANTS. **Zielinski, J. L. (Technical Univ., Warsaw). Inz. Budownictwo, 25: 121-7(1968). (In Polish).**

The following problems are discussed: prestressed concrete in reactor shells, shell prestressing methods, computing methods of pressurizing model tests on wall linings and insulation of storage tank cooling system, and cost of different parts of the tank. (auth) (NSA of Poland)

26427 LN$_2$ RECOVERY SYSTEM FOR ALICE (Engineering Materials). (California Univ., Livermore. Lawrence Radiation Lab.). (CAPE-1868).

9 drawings.

A liquid N$_2$ recovery system is described for use in the Alice thermonuclear device to supply 15° subcooled liquid N to vacuum liners and traps and a high mass flow of liquid N$_2$ to a trapping magnet for fast cool down and to separate the return two-phase fluid into gas and liquid. Gaseous nitrogen is vented and liquid N$_2$ is returned to the supply Dewar. The system is capable of handling up to 30 gpm of liquid N$_2$ and is fully automated. (For details see TID-4100 Suppl. 53.) (F.S.)

26428 B-XXIX ZONAL CENTRIFUGE **(Engineering Materials). (Oak Ridge Gaseous Diffusion Plant, Tenn.). (CAPE-1867).**

3 drawings.

A B-XXIX zonal ultracentrifuge is described that employs a double tapering scheme that allows gradient recovery from the rotor edge with resolution approaching that observed during center unloading. New procedures include edge loading of particles which will float up in the gradient and sequential recovery of sedimenting particles before they reach their isopycnic points. Particles such as viruses may be concentrated from liter volumes in a short steep edge gradient and recovered without using large volumes of dense displacing fluid. Some loss in resolution may occur in the lines through the septa where there is a reverse gradient. Average flow rate during unloading is ~40 ml/min giving an average velocity in the edge lines of 500 cm/min. The flow rate is sufficient to prevent excessive mixing due to the slight density inversion. (For details see TID-4100 Suppl. 53). (F.S.)

26429 DEVICE FOR CHANGING THE SPACING OF FUEL ELEMENTS IN A LATTICE. **Hachiya, Yuuki (to Nippon Electric Co.). Japanese Patent 1969-2674. Feb. 4, 1969. Filed May 20, 1966.**

A method is described for continuously changing the spacing of fuel elements in lattice arrangements. The change in the spacing is accurate and absolute and the construction of the spacing mechanism is solid. A plurality of wedges are arrayed between two supporting plates, one wedge engages with the next one, both being inverted with respect to each other. Four such arrays form the four sides of a lattice in which the fuel elements are inserted. Between the wedges on one side and those on the opposed side, beams are set, in this way the fuel element supports in the form of squares are produced on the plane of the lattice. Screws are installed at each corner of the lattice as a whole, the mechanism being operated with handles. The two lines of wedges in each array can be moved relative to each other by means of the screw mechanism. (NSA of Japan)

26430 FOUR POLE TURBINE GENERATORS FOR NUCLEAR POWER STATIONS. **Shiki, Moriya; Kai, Takashi (Mitsubishi Electric Corp., Kobe, Japan). Mitsubishi Denki Giho, 43: 491-500(Apr. 1969). (In Japanese).**

Nuclear power generation is now a worldwide trend to provide power for the future. Its reliability and economy are now recognized as fully competing with thermal power generation depending on fossil fuel. In the United States it is anticipated that a half of the steam turbine generators to start operation in 1972 will be nuclear powered. In Japan Mitsubishi has completed a nuclear power turbine generator to be installed as unit No. 1 in Mihama power station of Kansai Electric Power Co. This is the first machine of its kind built in Japan and is a 400 MVA 1,800 rpm 4 pole machine. Details of construction and test result are described. (NSA of Japan)

26431 REACTOR CONTROL DEVICE. **Torikai, Kinichi (to Japan Atomic Energy Research Inst.). Japanese Patent 1969-2675. Feb. 4, 1969. Filed Apr. 1, 1963.**

A reactor control device is described in which nuclear fuel in the form of gas is used. In this way, the reactor can be operated at temperatures so high that control rods or solid fuels would lose their integrity. The control is done by changing the pressure or density of fuel gas in the reactor core. In general, the gaseous fuel is used both for reactor control and cooling. The arrangement may be as follows: in the reactor consisting of the solid moderator, solid reflector and gaseous fuel, the pressure of the fuel gas is changed with a gas tank, pressurizer, and valves so that the main part of the fuel gas is circulated through an external heat exchanger. In addition to the above, solid fuel may also be incorporated, and the over-all operation is the same. In still another form in either a fast reactor or in a thermal reactor employing a gaseous moderator, reactor control again is similar to the above two. (NSA of Japan)

26432 DESIGN AND PERFORMANCE OF THE SANDIA LABORATORIES HERMES II FLASH X-RAY GENERATOR. Martin, Thomas Hugh (Sandia Labs., Albuquerque, N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 59-63(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

A flash x-ray generator, Hermes II, has been developed and constructed and has produced a bremsstrahlung radiation dose in excess of 6000 rads (H$_2$O) in 0.07 μs at a distance of one meter from the x-ray target, thus exceeding twice the single-pulse output of any similar laboratory source. This bremsstrahlung dose was produced by a 13-MV, 200-kA electron beam incident on the thick tantalum anode target of the x-ray tube. The oil-immersed generator is contained in a cylindrical tank 22 ft in diameter and 80 ft long and consists of a Marx capacitor bank as the primary energy store, a coaxial Blumlein transmission line, and an x-ray tube. The Marx bank charges the transmission line to 12 megavolts. The transmission-line energy, upon switching, accelerates an intense electron beam in the x-ray tube. To produce an operable generator, a nominally maximum 18-MV Marx generator had to be developed. Also, oil-immersed switches, oil-immersed transmission lines, support structures, and x-ray tubes have had to operate successfully at voltages exceeding 12 megavolts. (auth)

26433 DEVELOPMENT OF AN 18-MEGAVOLT MARX GENERATOR. Johnson, D. L.; Martin, T. H.; Prestwich, K. R. (Sandia Labs., Albuquerque, N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 64-9(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

A nominally maximum 18-MV, 1-megajoule oil-immersed Marx generator has been constructed and tested at 12 megavolt as the energy store of the Sandia Laboratories Hermes II flash x-ray machine. The generator has a relatively low inductance of 80 microhenries with 186 one-microfarad, 100 kilovolt capacitor stages and 93 individually packaged spark gaps. Model and circuit studies determined a geometrical layout for the capacitors which uses the stage-to-stage stray capacity to provide a wide spark triggering gap range (down to 40 percent of the self-breakdown voltage of the spark gaps) and rapid bank erection time. An analogue circuit study demonstrated that charged stray capacities between the generator and the container tank wall produce undesirable voltage transients which can be minimized by triggering the Hermes II generator at selected points. The mechanical support system of the generator minimizes the possibility of arc-over on the support insulators. A pressurized gas spark gap capable of being triggered was designed and used successfully in the Marx generator. The spark gaps operate from 40 kilovolt to over 300 kilovolt and conduct currents in excess of 100,000 amperes. During the gap development, arc erosion tests determining the degradation of the hold-off voltage with a number of high energy discharges were performed with several electrode materials. A tungsten-copper-nickel alloy was selected as the electrode material and a nitrogen-oxygen mixture as the fill gas. These gaps have successfully operated for over 35,000 gap firings in the generator. (auth)

26434 WELDING OF REFRACTORY METALS IN InFab. Bianchi, L. M.; McNeish, W. A.; Seman, D. J. (Universal-Cyclops Steel Corp., Bridgeville, Pa.). Met. Soc. Conf., 34: 91-112(1966).

From Conference on High Temperature Refractory Metals, New York. See CONF-524-(Pt. 2).

InFab, an inert atmosphere mill facility for the welding of refractory and reactive metals, is described. It consists of a room, 42 × 91 × 23 ft high, complete with welding equipment and with an atmosphere of high purity argon. The welding operator wears a special suit which provides him with a breathable atmosphere and which exhausts outside the room. A systematic program for evaluating the effects of major welding parameters on the finished joints in various refractory metals, including TZM, B-66, Ta-W alloy, and W, using the TIG welding process was undertaken, and the results presented. The effects of N_2 and O_2 on the bend transition temperatures of the various materials welds are illustrated, and results of chemical determination of the H_2, N_2, and O_2 content of the weld beads are given. It is concluded that InFab is an ideal facility for welding refractory metal components when a high-purity atmosphere is required and when the component being fabricated is large and/or complicated. (L.C.L.)

26435 NUCLEAR QUALITY: WAVE OF THE FUTURE. Irving, R. R.; Wilson, R. A. Iron Age, 202: 91-4(Dec. 12, 1968).

Section III of the ASME Boiler and Pressure Vessel code which is used as a guide for fabricators in the manufacture of nuclear pressure vessels is discussed. The maximum allowable content of sulfur and phosphorus is discussed. The establishment of manufacturers on rivers for barge shipment and field fabrication to supply the large pressure vessels weighing 1000 tons are described. A method for ensuring against brittle fracture based on the use of a ductile-to-brittle transition temperature for pressure vessels for water-cooled reactors is briefly discussed. (F.S.)

26436 RADIOACTIVE WELL LOGGING SYSTEM HAVING A MULTIPLE CONDUCTOR CABLE. Hopkinson, Eric C.; Youmans, Arthur H. (to Dresser Industries, Inc.). U. S. Patent 3,439,165. Apr. 15, 1969. Filed Jan. 6, 1965.

A pulsed D-T accelerator is housed with a gamma detector within a logging tool. The detector is gated in synchronism with the pulsation of the accelerator. The source-detector spacing maximizes desirable gamma reception and minimizes undesirable radiation detection. The discriminator setting of the detector is set within a range of 1.9 to 2.4 MeV, to further eliminate undesirable radiation detection. Neutron shielding, a mixture of boron-10 and epoxy resin, is arranged about the detector and instrument housing. An armored seven conductor cable, having its center conductor arranged to carry the logging detector output signal, connects the logging tool to the surface electronics. (Offic. Gaz.)

Heat Transfer and Fluid Flow

Refer also to abstracts 26397, 28402, 28423, 28446, 28453, 28512, 28541, 28555, 28585, and 28638.

26437 (AECL-3185) FLUIDIZED PARTICLE-TO-LIQUID HEAT TRANSFER. A DYNAMICIST'S VIEW. Trupp, A. C. (Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment). June 1968. 26p. (CONF-680546-1). Dep. CFSTI. CAN $1.00.

From 2nd Western Canadian Heat Transfer Conference, Vancouver, B. C.

Experimental observations on typical solids motion are presented from which certain general conclusions are drawn regarding the convective heat transfer coefficient pertinent to fuel design for a liquid fluidized bed nuclear reactor. The available literature was reviewed and the three main published correlations are shown to disagree. The most probable reasons for the discrepancies are outlined. An explanation is suggested to account for the apparent maxima in fluidized particle-to-liquid heat transfer coefficients at bed porosities of about 70%. Further experimental heat transfer work is strongly recommended. (auth)

26438 (AEEW-M-794) DIGITAL SIMULATION OF ONCE THROUGH BOILER DYNAMICS. Milsom, P. R. (Atomic Energy Establishment, Winfrith (England)). Mar. 1968. 28p. Dep. CFSTI. UK.

A basic mathematical model of a once-through boiler is derived. The procedure needed to determine its dynamic behavior using digital simulation is described in detail. The conservation of mass and momentum equations are used to describe the boiler in conjunction with an energy equation based on entropy rather than the more commonly used enthalpy equation. A considerable advantage in this work was the ease with which information from steam tables could be accurately represented in the digital programme. The equations are derived in a form which enables time to be continuously integrated, and the spatial derivatives are replaced by finite difference terms. The state variables are evaluated at fixed mesh points up the boiler. (auth)

26439 (AEEW-R-609) AN INVESTIGATION INTO THE EFFECTS OF A COSINE AXIAL HEAT FLUX DISTRIBUTION ON BURNOUT IN A 12FT LONG ANNULUS USING FREON-12. Stevens, G. F.; Wood, R. W.; Pryzbylski, J. (Atomic Energy Establishment, Winfrith (England)). Sept. 1968. 28p. Dep. CFSTI. UK 4s. 6d.

A semi-empirical scaling technique was developed with the object of enabling an experiment in Freon-12 at relatively low pressures to be used to predict the burnout characteristics of a boiling water channel at pressures up to 1000 psia. Burnout results are given for an annular test section 12 ft long and having an inner heated rod 0.625 in. diameter, and an outer unheated tube of 0.825 in. bore. In one case the rod was uniformly heated and in the other case the rod was given a symmetrical chopped cosine heat flux profile. The Freon data are shown to compare well with equivalent water data using the established scaling technique; this applied both to burnout power and to burnout position. The comparison was made at pressures of 1000 psia and 750 psia water equivalent and the same scaling factors are shown to work at both pressures. (auth)

26440 (AERE-R-5872) CONSTANT-RATE-INJECTION AND VELOCITY METHODS OF FLOW MEASUREMENT FOR TESTING HYDRAULIC MACHINES. Clayton, C. G.; Evans, G. V. (United Kingdom Atomic Energy Authority, Wantage (England). Research Group). Dec. 1968. 53p. Dep. CFSTI. UK 8s. 0d.

The principles and operation of radiotracer methods of flow measurement, which are now established for use during turbine and pump efficiency tests, are described. Instructions are given for carrying out these measurements so that satisfactory results can be obtained, and an example is included of the method of calculating the results and of deriving the errors to 95% confidence limits. (auth)

26441 (AWRE-O-9/69) TEMPERATURE DISTRIBUTIONS ON CONDUCTION-COOLED MICROCIRCUIT SUBSTRATE SURFACES BY RELAXATION ANALYSIS. Dean, D. J.; Taylor, J. C. (Atomic Weapons Research Establishment, Aldermaston (England)). Feb. 1969. 22p. Dep. CFSTI. UK 3s. 6d.

A new physical model is introduced to allow the accurate calculation of substrate surface temperatures by relaxation analysis. Simple two- and three-dimensional distributions may be calculated manually, and a specific example is calculated to an accuracy of 1%. More complex situations are readily amenable to computer techniques. (auth)

26442 (BNL-50142) ABNORMAL BUBBLE MOVEMENT AND INDUCED "ROLL CELL" FORMATION IN FLUIDIZED BEDS. Sears, John T. (Brookhaven National Lab., Upton, N. Y.). June 1968. 10p. Dep. CFSTI.

In contrast to the normal pattern of downward motion of particles adjacent to the wall, a "roll cell" of particles was visually observed through a glass column in an aggregatively-fluidized bed. Due to the effect of a nonuniform magnetic field, a mixture of iron and glass particles rose on one side of a column and returned on the other. Apparently bubble motion can be influenced by the particles themselves, and an induced lateral movement of the rising bubbles causes this change in the particle motion patterns. (auth)

26443 (LIB/Trans-197) THE INFLUENCE OF ARTIFICIAL ROUGHNESS ON THE INCREASE IN THE CRITICAL HEAT FLUX DENSITY OF WATER IN ANNULAR SPACES UNDER FORCED CONNECTION. PART I. SUBCOOLED STATE AT THE MEASURING SECTION OUTLET. Burck, E.; Hufschmidt, W.; de Clercq, E. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Translated by Peter J. F. Newton (Australian Atomic Energy Commission Research Establishment, Lucas Heights), from report EUR-4040. 79p. Dep.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 2496. (R.C.K.)

26444 (UCRL-50589) COMPILATION OF THERMAL PROPERTY DATA FOR COMPUTER HEAT-CONDUCTION CALCULATIONS. Edwards, A. L. (California Univ., Livermore. Lawrence Radiation Lab.). Feb. 24, 1969. 78p. Dep. CFSTI.

Thermal property data including density, specific heat, and thermal conductivity have been tabulated against temperature, transition temperatures, and latent heats of transition for more than 1000 materials. These data were collected from over 50 references, most of which contain extensive data tabulations and bibliographies. The data were arranged on computer cards and magnetic tape in a format suitable for computer processing, with the materials identified numerically according to a general and flexible classification system. An accompanying alphabetical index, also in card and magnetic tape form, describes each material, assigns it an identification number, references the sources of the data by code number, and codes the quality or reliability of the data. The gram-cm-sec-cal-°C unit system is used for all data. In addition to the data obtained from the sources listed, estimates also were made for many materials for which data could not be found wherever they appeared to be as accurate as measured values for similar materials. A computer program was written to search the material data list for specific material identification numbers and, if desired, to convert the data to a new unit system and transfer the selected data to another tape. This second tape, in turn, can be used either as an input tape or as a means for producing punched cards. The computer program has been incorporated into the TRUMP computer program as a subroutine. (auth)

26445 HEAT TRANSFER IN THE AGR FUEL ELEMENT. Jansen, F. (Brown, Boveri and Cie AG, Mannheim, Ger.). Kerntechnik, 11: 146-51(Mar. 1969). (In German and English).

The AGR fuel element consists of a cluster of fuel pins. These are thin-walled stainless steel tubes filled with cylindrical UO$_2$ pellets. By means of an appropriate arrangement of the pins and by roughening the pin surface (transverse ribs of a low height) the quantity of heat removed from the reactor is increased considerably at the cost of a relatively small increase of the blower power required. Heat transfer experiments which resulted in the optimal rib dimensions are described and an example of calculations of canning and fuel temperatures in an AGR fuel element are presented. (auth)

26446 THE THEORETICAL APPROACH TO THE CRITICAL FLOW RATE IN TWO PHASE FLOW. 5. A FEW PROBLEMS APPEARING IN DISCHARGING OF SATURATED WATER THROUGH ORIFICES. Ogasawara, Hideo (Hitachi Ltd., Tokyo). Nippon Kikai Gakkai Rombunshu, 34: 2146-54(Dec. 1968). (In Japanese).

In case of unforeseen fracture of the primary cooling system in the liquid-cooled reactor, it is necessary to understand the actual condition of discharging phenomenon in order to estimate the scope of the accident. A flow analysis that was carried out on the short channel with negligible friction loss of flow, combining the theory of two phase critical flow with the upper stream condition is reported. The experiment of discharging saturated water of 70 atm pressure in a pressure vessel through orifices of 10 to 70 mm bore was carried out, and accuracy of applying the critical flow model was investigated. The saturated critical flow with negligible friction loss can be analyzed easily by combining the upper stream pressure and amount of vapor with the critical conditions. In comparison with the experimental values, the conformity of the model was not good when the amount of vapor at the entrance was small, but more promising results were obtained when the amount of vapor was large. This was due to ambiguity in the applicable range of the saturated flow model and the method used to estimate the amount of vapor. (NSA of Japan)

26447 ANALYTICAL AND EXPERIMENTAL STUDY OF SODIUM HEAT PIPES. Semeria, R.; Schmidt, E. (CEN, Grenoble, France). Bull. Inform. Sci. Tech. (Paris), No. 132, 31-48 (Dec. 1968). (In French).

The results obtained in the course of theoretical and experimental studies carried out on sodium heat pipes, the capillary structure of which is made up of square-mesh sieves are discussed. The chief aim of this work was to determine the thermal power limit of the apparatus as a function of several parameters, with special reference to the specifications of the capillary network. (auth)

26448 THERMAL CONTACT CONDUCTANCE. Cooper, M. G. (Cambridge Univ., Eng.); Mikic, B. B.; Yovanovich, M. M. Int. J. Heat Mass Transfer, 12: 279-300(Mar. 1969).

The resistance to the flow of heat between two thick solid bodies in contact in a vacuum is considered. Existing analyses of single idealized contacts are summarized and compared, and then applied, together with results of recent electrolytic analog tests, to predict the conductance of multiple contacts, "appropriately" or "inappropriately" distributed at the interface. Reconsideration of the theory of interaction between randomly rough surfaces shows how the parameters required to predict heat transfer can be determined in principle by simple manipulation of typical profiles of the mating surface, together with an approximation from deformation theory. It is also shown that this process depends more crucially than had been realized upon the distribution of the few high peaks of the surfaces, where the assumption of Gaussian distribution of heights is suspect. In place of that assumption the use of describing functions is suggested. The few experimental data relevant to these theories are examined and compared with predictions of theory. (auth)

26449 STUDY OF THE HEAT TRANSFER BETWEEN THE CHANNELS AND HEAVY WATER IN A NUCLEAR REACTOR. Faure, J. (EURATOM, Ispra, Italy); Jaumotte, A. Int. J. Heat Mass Transfer, 12: 155-72(Feb. 1969). (In French).

The risk of local boiling of the moderator in a pressure tube reactor was investigated. For various coolant channel concepts it was shown how the inlet temperature of the moderator must be chosen to avoid this condition. An experimental study showed the unstable character of the downward flow of the moderator. It was verified that the orifices of the distribution plates caused local increase of heat transfer. (auth)

26450 GAS MIXING IN ROD CLUSTERS. Skinner, V. R.; Freeman, A. R.; Lyall, H. G. (Central Electricity Generating Board, Berkeley, Eng.). Int. J. Heat Mass Transfer, 12: 265-78(Mar. 1969).

Transverse temperature differences in a coolant flowing axially along a rod cluster or tube bundle will be reduced by diffusion of heat from one sub-channel to another through the gaps between the rods or tubes. This process, called mixing, for convenience, was studied experimentally using a mass-transfer analogy. Mixing rates were found to be greater than could be explained by turbulent diffusion theory. They were attributed to the action of secondary velocities. The results were used to predict the extent to which mixing will reduce temperature differences within fuel clusters of Advanced Gas-Cooled Reactors. (auth)

Isotope Technology

Refer also to abstracts 26323, 26411, 26418–26420, 27003, 27038, and 28658.

26451 (BNL-13564) ^{99m}Tc: AN INEXPENSIVE ROUTE TO A VERSATILE RADIOISOTOPE. Richards, P. (Brookhaven National Lab., Upton, N. Y.). Apr. 22, 1969. 24p. (CONF-690508-1). Dep. CFSTI.

From Conference on Radiation and Isotope Technology in Latin American Development, San Juan, Puerto Rico.

The use of short-lived isotopes in medical diagnostic procedures is one of the areas showing the most rapid growth in the use of radioisotopes today. Two short-lived radionuclides, ^{18}F and ^{99m}Tc, in the form of various labeled pharmaceuticals are useful in most of today's clinical procedures. Both of these nuclides can be produced in reactors available to these centers. A solvent extraction technique was developed that makes possible the separation of the high quality ^{99m}Tc from low-specific activity parent ^{99}Mo. The development of a close working arrangement between nuclear and medical centers can result in a modern nuclear medicine program using these nuclides and which can be carried out with a maximum degree of self sufficiency. (auth)

26452 (BNL-50126) FUDGE 4A: A COMPUTER PROGRAM FOR GAMMA DOSE RATE DISTRIBUTION FROM RECTANGULAR SOURCES. Galanter, Leonard; Krishnamurthy, Krishnaswamy (Brookhaven National Lab., Upton, N. Y.). Aug. 1968. 28p. Dep. CFSTI.

A computer program, FUDGE 4A, is presented that is used to determine the distribution of gamma dose to large volume targets from rectangular source plaques. The program was written for FORTRAN IV for the CDC-6600. (F.S.)

26453 (CEA-CONF-1269) GASEOUS ULTRACENTRIFUGE FOR THE SEPARATION OF THE URANIUM ISOTOPES. Bourgain; le Manach; Berthoumieux. [nd]. 19p. (In French). (CONF-681015-5). Dep.

From Symposium on Problems Bearing on Isotope Separation of Uranium, Turin, Italy.

Several prototypes of centrifuges have been perfected in France by the CEA. Their operation is safe and their power of separation is close to the theoretical. With the purpose of increasing the income from the process all efforts lead to the reduction of the investments, the decrease of the electric power, and the increase of the peripheral speeds. The results obtained make it possible to hope that centrifugation will become an economical process in the near future for use in isotopic separation of average amounts. On the other hand we actually can only predict with reservations the competitiveness of this process with gaseous diffusion for large amounts. Only a strong effort in development and industrialization would give a chance to this process. Thus it would appear hardly reasonable to see the limited European means dispersed at the same time on variant forms and different equipment working in parallel. A regrouping and a cooperation are very desirable. Whatever comes of it, even if centrifugation does not develop into an industrial realization, it will make possible theoretical and technological domains the obtaining of useful experience in other branches of industry. Among theoretical studies, we shall cite those related to the mechanics of deformable and nondeformable solids, the studies of pieces in rotation in connection with the mechanics of continuous media, thermal studies, and aerodynamic studies. In the domain of technology we shall cite the metallurgical studies, the studies of bearings and supports, and studies of air- and water-tight devices. (tr-auth)

26454 (CONF-670649-22) APPLICATIONS OF RADIOISOTOPES IN ELECTROANALYSIS. Almagro Huertas, V.

(Junta de Energia Nuclear, Madrid (Spain)). [1966]. 13p. (In Spanish). Dep.

From Symposium on Applications of Radioisotopes, Madrid, Spain.

The application of radioisotopes in electroanalysis is based on the substitution of the measurement of the electrolysis current by the measurement of the radioactivity of an isotope deposited on the electrode under the same conditions which exist in the normal electroanalytical method. The electroanalytical techniques which have been aided by the application of radioisotopes are polarography, amperometry, and coulombimetry. The experimental techniques used and the best known applications are described. The simultaneous determination of ^{95}Zr−^{95}Nb and of ^{106}Ru−^{106}Rh are described as examples. (J.S.R.)

26455 (JAERI-5020) ANNUAL REPORT OF DIVISION OF RADIOISOTOPE PRODUCTION, APRIL 1967–MARCH 1968. (Japan Atomic Energy Research Inst., [Tokyo]). Nov. 1968. 87p. (In Japanese). Dep.

The following major achievements of the JAERI Division of Radioisotope Production for fiscal year 1967 are reported. The installation of production facilities was almost completed. The routine mass production of ^{131}I and ^{32}P was started. The total radioactivity handled at the laboratory reached about 4,500 Ci in fiscal year 1967. The amount of radioactive products shipped exceeded 1,735 Ci. The domestic production of ^{198}Au and radiation sources spurred the needs for these two products, bringing a remarkable expansion in the scale of supplies. JAERI's radioisotope production started in October 1962, with the achievement of domestic and routine mass production of ^{35}S, ^{198}Au, ^{131}I, and ^{32}P. In order to ensure the steady supply of the products the radioisotope production and reactor operation plans were adjusted appropriately. The accomplishment of the first five-year program allowed new projects to start. Production of ^{60}Co radiation sources with a specific activity of 6 Ci/g was started. Other achievements included a joint research project with Tin-Hua University in Taiwan, and the development of ^{132}Te and ^{99}Mo preparation techniques. (auth)

26456 (LIB/Trans-194) BRIEF DISCUSSION ON A PLANT FOR SEPARATING ^{235}U BY GAS CENTRIFUGATION. ECONOMIC EVALUATION OF A NOVEL GAS CENTRIFUGATION PROCESS BASED ON CERTAIN ASSUMPTIONS. Kikuchi, H. Translated by P. L. Nicol (Australian Atomic Energy Commission Research Establishment, Lucas Heights), from Nippon Genshiryoku Gakkaishi, 10: 441-3(1968). 6p. Dep.

An abstract of this paper, prepared from the original language, appeared as NSA 22: 51149. (L.C.L.)

26457 (MLM-1642) THE EFFECTIVE ALPHA ACTIVITY OF ^{238}Pu DIOXIDE MICROSPHERES. Huffman, Gary N. (Mound Lab., Miamisburg, Ohio). Apr. 1969. Contract AT(33-1)-Gen-53. 104p. Dep. CFSTI.

Thesis. Submitted to Univ. of Dayton, Ohio.

Measurements were made of the effective alpha activity emitted at the surfaces of ^{238}PuO$_2$ sol-gel microspheres as a function of their spherical diameters. The isotopic ratios and conversion factors for ^{238}Pu/^{239}Pu were calculated. Emission fractions and the range of an alpha particle were calculated using Kershner's relationship. The range in ^{238}PuO$_2$ is found to be 12.3 ± 0.1 microns, in agreement with previous estimates. (D.L.C.)

26458 (N-68-38170) ISOTOPE REENTRY VEHICLE DESIGN STUDY. CONCEPTUAL DESIGN. PHASE IB: TOPICAL REPORT. Shure, Lloyd I. (Avco Corp., Lowell, Mass. Avco Space Systems Div.). Oct. 1968. Contract NAS3-10938. 324p. (NASA-CR-72463; AVSSD-0193-68-CR). CFSTI.

A study to develop a preliminary design of a 25 kW(t) plutonium-238-fueled Isotope Reentry Vehicle (IRV) is described. Major design emphasis was on system safety and developability. The IRV was configured to meet minimum practical diameter and weight limits. Heat source, and heat-source heat exchanger concept combinations were developed and evaluated. Three IRV systems were studied in a detailed conceptual design evaluation in Phase 1B: a minimum diameter circular planar Heat Source (HS) Array (with nonvented capsules); a minimum diameter circular planar Heat Source (HS) Array (with vented capsules); and a minimum diameter pin cushion HS Array (with nonvented capsules). The primary objective of Task 1B was to develop candidate designs to the level required for performance comparison and then to recommend one IRV for preliminary design. (auth) (STAR)

26459 (ORNL-4283) STUDY OF ^{171}Tm AS A POWER SOURCE FOR CIRCULATORY SUPPORT SYSTEMS. Poggenburg, J. K. (Oak Ridge National Lab., Tenn.). May 1969. Contract W-7405-eng-26. 45p. Dep. CFSTI.

Thulium-171, which has been proposed as a candidate for use as a power source in circulatory support systems because of its apparent low shield weight requirements and potential availability, was studied and compared with another candidate, ^{238}Pu. One of the desirable features of ^{238}Pu for this application is its low dose rate of 35 mrem/hr at 10 cm from the center line of a 1-lb source. The initial amount of ^{170}Tm activity in a ^{171}Tm source, based on a total source and shield weight allowance of 1 lb, would have to be in the ratio of 10^{-4} to 10^{-5} for the dose rate to be comparable to that for the ^{238}Pu source. The technical and economic factors associated with producing a ^{171}Tm product which meets this requirement were considered for each of three possible reactor target materials: natural erbium, natural thulium, and enriched ^{170}Er. The limited production capabilities and extremely high estimated cost—exceeding $30,000 per watt—led to the conclusion that ^{171}Tm is not a practicable power source for large-scale use in the Artificial Heart Program. (auth)

26460 METHODS FOR THE SEPARATION OF URANIUM ISOTOPES. Becker, E. W. (Univ., Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.). Kerntechnik, 11: 129-39 (Mar. 1969). (In German and English).

The nuclear reactors of the western world are supplied with uranium-235 concentrate mainly by the three American gaseous diffusion plants. Within a few years the demand is expected to outgrow the capacity of these plants. The three enrichment methods presently under consideration for new plants, e.g., the gas diffusion process, the ultracentrifuge process, and the separation nozzle process are described. Their technological and economic aspects are compared. (auth)

26461 STABLE ISOTOPE RATIOS OF DISSOLVED INORGANIC CARBON IN THE ATLANTIC. Deuser, W. G.; Hunt, J. M. (Woods Hole Oceanographic Inst., Mass.). Deep-Sea Res. Oceanogr. Abstr., 16: 221-5(Apr. 1969).

δ ^{13}C values of oceanic inorganic carbon from six stations in the North and South Atlantic vary between −1 and +2‰ relative to the PDB standard. A correlation between the concentration of dissolved oxygen and δ ^{13}C is observed at all stations below the top 200 meters. The correlation is due to the oxidation of organic matter depleted in ^{13}C. The extent of the isotope shift in the dissolved inorganic carbon is a measure of the amount of organic carbon oxidized. (auth)

26462 THERMOELECTRIC GENERATOR ASSEMBLY. (to Martin-Marietta Corp.). British Patent 1,151,084. May 7, 1969. Priority date July 26, 1965, United States.

An improved thermoelectric generator is described which consists of a heat source and thermopile subassemblies in modular form to allow field replacement. The heat source module consists of a ^{90}Sr source contained in a cast iron container either cylindrical or cup shaped. Shielding of W, depleted U or Mo−U alloy, and fibrous insulation are employed. (F.S.)

26463 MODEL STUDIES FOR WEAR MEASUREMENT IN SOIL PROBES WITH THE AID OF RADIONUCLIDES. Wuenschmann, Manfred; Hautsh, Hans-Juergen (Technische Hochschule, Karl-Marx-Stadt, Ger.). Wiss. Z. Tech. Hochsch. Karl-Marx-Stadt, 9: 131-3(1967). (In German).

A method for measuring wear in rotary mining drills was developed which used a neutron-activated insert placed in the drill probe. Measurement of the wear was made from the γ emission from ^{59}Fe and was correlated with the rotational speed of the probe shaft. Results obtained with soft steels were more consistent than with hardened steels, where the wear data were more variable. The moisture content of soil samples was an important factor and increased wear was observed up to 6 or 8% moisture content. Above this value the wear decreased markedly. Use of the neutron-activated radionuclide reduced drill wear measurement time without any increase in the measurement error, as compared to other wear measurement methods. (BBB)

26464 CHEMICAL AND FOOD APPLICATIONS OF RADIATION. NUCLEAR ENGINEERING. PART XIX. Brownell, Lloyd E.; Josephson, Edward S.; Manowitz, Bernard; Harmer, David E. (eds.). Chem. Eng. Progr., 64: Symp. Ser. No. 83, 1-149(1968). (CONF-660903; CONF-661201).

From American Inst. of Chemical Engineers Meeting, Atlantic City. American Inst. of Chemical Engineers Symposium, Detroit.

A separate abstract was prepared for each of the 15 sections of this report. Nine of the papers are from the symposium "Progress in Food Irradiation" and six are from the symposium "Industrial Radiation Chemical Processes." (E.R.B.)

For abstracts of individual papers see: 26277–26280, 26417–26420, 26465, 26466, and 26978–26982.

26465 PROGRESS IN ^{137}Cs IRRADIATION SOURCES FOR FOOD PROCESSING. O'Sullivan, E. T. (Isochem Inc., Richland, Wash.); Harvey, R. W.; Greenborg, Jess. Chem. Eng. Progr., 64: Symp. Ser. No. 83, 31-41(1968).

From American Inst. of Chemical Engineers Meeting, Atlantic City. See CONF-660903.

Cesium-137 is the most suitable isotopic source available in large quantities for food irradiation. Reasons, discussed in detail, include availability, source geometry, encapsulation details, present and projected costs, depth-dose distribution, shielding requirements, and replacement problems. (auth)

26466 STATUS OF GAMMA IRRADIATION DESIGN. Manowitz, Bernard (Brookhaven National Lab., Upton, N. Y.). Chem. Eng. Progr., 64: Symp. Ser. No. 83, 16-30(1968).

From American Inst. of Chemical Engineers Meeting, Atlantic City. See CONF-660903.

Gamma irradiators make use of nuclear radiation for the destruction of bacteria and for the initiation of chemical reactions. They consist of a radioactive source, a target, a means for getting the target in and out of the radiation field, and shielding. ^{60}Co and ^{137}Cs are typical radioactive source materials. The efficiency of the irradiator and many of its design characteristics depend upon chosen source-to-target configurations. ^{60}Co and ^{137}Cs are compared under a variety of design conditions. (auth)

26467 PROSPECTS OF INCREASING USE OF RADIOISOTOPES IN THE MANUFACTURING INDUSTRY. Com. Naz. Energ. Nucl., Notiz., 14: No. 12, 95-8(Dec. 1968). (In Italian).

A discussion of the prospects for using radioisotopes in the manufacturing industries of the countries of the European community, as they appear from a survey conducted by COMISOTOP, is given. (auth)

26468 NUCLEAR BATTERY. (to International Business Machines Corp.). British Patent 1,151,247. May 7, 1969. Priority date Nov. 19, 1965, United States.

A nuclear battery is described which utilizes a gaseous radioactive material without resorting to high pressure containers. The battery has an emitter electrode consisting of a solid conductor in which is dispersed a radioactive material and a collector electrode. The electrodes are in sheet form and are arranged in interpenetrating coils. (F.S.)

26469 THERMOELECTRIC CONVERSION MODULE. (to Martin-Marietta Corp.). British Patent 1,151,083. May 7, 1969. Priority date July 26, 1965, United States.

A low cost, highly flexible, easily assembled, safe radioisotope-powered thermoelectric generator is described. The generator is easily disassembled allowing replacement of the isotopic fuel without using a hot cell. The modular design allows field maintenance without breaking module seals. (F.S.)

26470 RADIOISOTOPE DETERMINATION OF REFRACTORY WEAR IN STEEL PLANTS. Baez, J. N.; Wortman, O.; Zaretzky, Z. Metalurgia (Sao Paulo), 24: 353-8(May 1968). (In Portuguese).

The preparation of three capsules containing ^{60}Co, the manner of their placement in the wall of a 500-ton pig iron mixing ladle and readings taken on two different dates are presented. This capsule and its installation were designed to determine wear at the critical area near the pouring spout of the ladle. Data show that the amount of radioactivity was not harmful to personnel. To determine wear in hearth areas of blast furnaces, a method of isotopic dilution of melts was developed, using ^{59}Fe as the tracer. (auth)

26471 MECHANISM OF DIFFUSION AND ISOTOPE EFFECTS IN LIQUID METALS. Belashchenko, D. K. Izv. Vyssh. Ucheb. Zaved., Chern. Met., No. 9, 20-6(1968). (In Russian).

The phenomenology of the separation of isotopes in two-isotope metallic liquids and the corresponding macroscopic flow of electric current in a hypothetically monogenetic solution are discussed. (Metals Abstr.)

26472 PLATE RADIATION SOURCE AND ITS PRODUCTION METHOD. Asada, Tahei. Japanese Patent 1969-2678. Feb. 4, 1969. Filed Nov. 20, 1963.

A method for the production of plate-type radiation sources that have the following advantages is described: ease of machining due to its aluminum base plate; no peeling due to the radioactive metallic oxide attached into the aluminum plate oxide film; high chemical stability due to the state of its introduction; and choice of radioactivity resulting from its thickness on the plate surface. The method of production consists of precipitating an oxide of a metallic element in Group I to VIII into the oxide film of a plate of aluminum or its alloy, and using an acid solution containing the radioisotope of a metallic element in Group I to VIII as an electrolyte. A plate of aluminum or its alloy with or without a surface oxide film, and a plate of carbon, tin, lead, iron, or aluminum are used as electrodes. An ac electric current is passed through the electrolyte to precipitate the radioactive metallic oxide into the oxide film of the aluminum or its alloy plate. (NSA of Japan)

26473 ISOTOPE TARGETS FOR SOVIET NUCLEAR RESEARCH. Energ. Nucl. (Paris), 10: 524-5(Dec. 1968). (In French).

Four types of isotope targets for Soviet nuclear research are briefly described. These are thin metallic layers in the free state deposited on the support, thermostable emulsions, layers compressed in various isotopic materials, and isotopically pure enriched metals and monocrystals. The quality control of these targets is briefly discussed. (J.S.R.)

26474 ENRICHED URANIUM SUPPLY AND DEMAND. ECONOMIC FACTORS. Witzke, R. L.; Smith, E. E.; Bach, J. H. (Westinghouse Electric Corp., Pittsburgh). Proc. Amer. Power Conf., 30: 211-22(1969).

From 30th Annual American Power Conference, Chicago, Ill. See CONF-680418.

Available data on uranium reserves and resources were studied in an evaluation of future trends of nuclear power. Uranium availability will influence the nuclear industry but in an orderly expansion of nuclear capacity, there need be no concern about the availability of U for the plants committed at any one time. The availability of enrichment services at reasonable prices will influence nuclear capacity. The possible transfer of enrichment services to private industry was studied and it was found that private industry can supply enrichment services at no significant price increase over AEC prices. Factors affecting the economics of enrichment services are described. (F.S.)

26475 PRODUCTION OF VARIABLE-ENERGY CALIBRATING RADIATION BY COMPTON SCATTERING. Leimgruber, R. A.; O'Foghludha, G. (Medical Coll. of Virigina, Richmond). Nucl. Instrum. Methods, 70: 331-6(May 1, 1969).

Some uses of variable-energy gamma rays are described and methods of generating them are summarized. Experiments are reported on the use of one such method in calibrating scintillation detectors. Monoenergetic photons are Compton-scattered from a small object and those entering a small angle are viewed by the detector; selection of various scattering angles allows the calibrating energy to be varied at will. An apparatus is described which includes a box-like "cavity collimator" designed to eliminate radiations scattered from the laboratory walls. Pulse-height spectra obtained with the equipment are presented and the effects on them of the energy-spread inherent in the technique are discussed. The drawbacks of the method at very low and very high energies are mentioned and a method of overcoming them in the region up to 10 MeV is suggested. (auth)

26476 THE SITUATION OF URANIUM ENRICHMENT IN EUROPE. Scuricini, Giovanni B. Com. Naz. Energ. Nucl., Notiz., 15: No. 4, 43-5(Apr. 1969). (In Italian).

After briefly discussing the activities of the Foratom and Euratom Study Groups on uranium enrichment, import aspects, urgency, economics, and need for electric power are reviewed. The economics of the gaseous diffusion and ultracentrifugation processes are discussed. (F.S.)

Materials Testing

Refer also to abstracts 26161, 26405, 26623, 26996, 27049, 27058, 28214, 28504, and 28567.

26477 (AERE-Bib-164) SELECTED BIBLIOGRAPHIC GUIDE TO CONFERENCE PAPERS ON NONDESTRUCTIVE TESTING, 1955-1967 (WITH ABSTRACTS). Morgan, R. (Atomic Energy Research Establishment, Harwell (England)). Dec. 1968. 271p. Dep. CFSTI. UK 35s. 0d.

References to Conference Papers are arranged in four main categories: International Conferences, U.K. Conferences, U.S. Conferences, and Other Conferences. These categories are subdivided into individual Conferences, giving titles, sponsors, date and venue. Author, subject and venue indexes are provided. (UK)

26478 (BNWL-988) ULTRASONIC VELOCITIES AND CRITICAL-ANGLE-METHOD CHANGES IN IRRADIATED A302-B AND A542-B STEELS. Hunter, D. O. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 1969. Contract AT(45-1)-1830. 150p. Dep. CFSTI.

Ultrasonic critical-angle-method amplitude changes and ultrasonic shear and longitudinal velocity changes are measured on reactor irradiated A302-B and A542-B low alloy steels. For specimens irradiated at temperatures between 140 and 350°F, shear velocity decreased from about 0.2% at 1.5×10^{18} nvt to 0.6% at 1 to 2×10^{20} nvt. Longitudinal velocity decreased from 0.1% to 0.3% at similar fluences. Measurements of velocities changes for specimens irradiated at temperatures between 610 and 680°F were inconclusive due to the small changes. There were indications, however, that high temperature irradiated specimens had experienced increased velocities before decreasing velocities trends were established. Critical angle amplitude changes are generally comparable to velocities changes. Anomalies in velocities and critical angle curves are thought to be primarily as a result of scatter in unirradiated material and irradiation temperature variations among test specimens. Neutron energy-spectrum variations also could feasibly have contributed to anomalies. Possible radiation damage and recovery mechanisms are discussed along with their possible effects on elastic constants. Measurements methods and apparatus are described. (auth)

26479 (BNWL-997) DETECTION OF INCIPIENT FAILURE IN NUCLEAR REACTOR PRESSURE SYSTEMS USING ACOUSTIC EMISSION. Hutton, P. H. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 1969. Contract AT(45-1)-1830. 38p. Dep. CFSTI.

Development work to apply acoustic emission detection as a means of continuously monitoring nuclear reactor pressure boundaries for flaw formation and/or growth is summarized. The nature of the acoustic emission signal has been clarified, specialized detection techniques have been developed, identification of acoustic emission in the presence of hydraulic noise has been demonstrated, and the technique has been beneficially applied to selected problems both in the field and in the laboratory. (auth)

26480 (BNWL-1008) ACOUSTIC EMISSION SIGNAL ANALYSIS IN FLAT PLATES. Fitch, C. E. Jr. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 1969. Contract AT(45-1)-1830. 34p. Dep. CFSTI.

An acoustic emission signal from a deformation or fracture mechanism is assumed to initiate as essentially a point source for detection frequencies in the range of a few megahertz or below. Approximate mathematical expressions for predicting the number of signal reflections and their time separations, and thus total expected signal durations, were derived and studied for flat specimen geometries. A $\frac{1}{2}$-in. thick A-212-B steel plate was used to determine whether experimental observations could be predicted from approximate relationships derived. Both artificial and real acoustic emission sources were tested under a variety of conditions. Observations of good experimental agreement may provide a basis for optimizing signal detection in flat geometries. A preliminary study of pulse shapes and pulse durations was also conducted in experimental attempts to determine source depth as well as range. (auth)

26481 (BNWL-SA-2207) ULTRASONIC NONDESTRUCTIVE MEASUREMENT OF IRRADIATION DAMAGE IN STEEL. Hunter, D. O. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov. 18, 1968. Contract AT(45-1)-1830. 20p. (CONF-690318-1). Dep. CFSTI.

From Metals Engineering National Conference, Washington, D. C.

The feasibility of ultrasonic methods for measuring radiation damage manifested by embrittlement in low alloy steels and loss of ductility in austenitic steels was investigated. Steels tested included ASTM A302 B used in reactor pressure vessels, ASTM A542 B considered for pressure vessel use, and AISI 304 austenitic stainless steel proposed for use in fast flux reactors. Results showed that changes in velocity were a principle cause of the change in critical angle method signal. It is probable that a relationship can be established between the ultrasonic critical-angle response and the shift in nil ductility-transition temperature if the irradiation temperature is known. Ultrasonic response to damage in 304 stainless steel is similar to that in low alloy steel. It appears that ultrasonic testing methods are useful laboratory tools to study radiation damage and recovery for polycrystalline alloys. (F.S.)

26482 (EUR-4101, pp 211-16) EXPERIMENTS TO EXAMINE THE EFFECT OF RAPID STRAIN RATES ON FULL SCALE AND MODEL SCALE REACTOR MATERIALS. Rees, N. J. M. (Atomic Weapons Research Establishment, Foulness (England)).

Model measurements on the mechanical safety of fast reactors to internal explosion are impaired by the practical necessity of using water instead of Na as coolant, conducting the experiments at low temperature, and substituting mild steel construction materials for stainless steel. Equipment and procedures used in experiments to compare the dynamic properties of small stainless steel specimens at elevated temperatures and the full scale rate of straining with the properties of the mild steel at the model rate of strain are described. (H.D.R.)

26483 (GA-9308) NONDESTRUCTIVE TESTING DURING FABRICATION AND INSTALLATION OF THE FORT ST. VRAIN NUCLEAR POWER REACTOR. Brown, J. L. (Gulf General Atomic, Inc., San Diego, Calif.). Apr. 15, 1969. Contract AT-(04-3)-633. 20p. (CONF-690504-1). Dep. CFSTI.

From American Society for Nondestructive Testing Conference, Denver, Colo.

Nondestructive examinations begin with the raw materials to be utilized for nuclear components. Eddy currents, helium leak testing, hydrostatic testing, liquid penetrant, radiography, ultrasonic inspection, and wet magnetic particle methods are performed. Testing occurs during all phases of fabrication. Weld joints, cut edges of plates, forgings, openings, and fittings are examined. (J.C.W.)

26484 (IFA-M-41) QUANTITY OF RADIOGRAPHIC QUALITY. Panaitescu, Iulian (Academia R. P. R., Bucharest. Institutul de Fizica Atomica). [1968]. 13p. (CONF-680951-1). Dep.

From 3rd Conference on Nondestructive Testing, Gottwaldow, Czechoslovakia.

The concept of radiographic image quality is defined and analyzed in terms of the informational content of the image, using the methods of information theory. It is shown that contrast, sharpness and graininess are the main elements that determine the quality of an image. These elements are related to the more general concepts of modulation transfer function and noise. Two properties of the information channel are discussed: sensitivity, based mainly on contrast, and resolving power, based mainly on definition (a property inversely related to sharpness and graininess). Natural or artificial flaws are classified into critical and overcritical ones, according to their cross section. The image of critical flaws is sensitive to definition, whereas the image of overcritical ones is sensitive only to contrast. The design and use of image quality indicators (IQI) are critically discussed, with respect to their informational properties. More comprehensive IQI's and image quality indexes are discussed. (auth)

26485 (KURRI-TR-30) REPORT OF SPECIAL COMMITTEE ON NONDESTRUCTIVE TESTING. Katsurayama, Yukinori; Tsujimoto, Tadashi (Kyoto Univ. (Japan). Research Reactor Inst.). [nd]. 57p. (In Japanese). Dep.

The report comprises six papers which were presented at two conferences held on March 22, and September 28, 1966. The papers include "Status of Radiography Using ^{192}Ir," "Neutron Radiography," "Thickness Determinations with the Use of Radiation," "Integrity Testing using ^{192}Ir," "Problems in Designing Pressure Vessels," and "Testing Specifications for Pressure Vessels." The last paper covers testing by radiation transmission measurements, supersonic testing for faults, and magnetic particle inspection. (TTT)

26486 (ORNL-tr-1936) [DETECTION OF WELD DEFECTS OPENING ONTO THE SURFACE THROUGH USE OF AMMONIA GAS]. Chretien, N.; Chretien, J. F.; Cortley, P. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Translated for Oak Ridge National Lab., Tenn., from Symposium on Nondestructive Testing and Control in the Field of Nuclear Metallurgy and Technology, Saclay, France. 24p. Dep. CFSTI.

An abstract of this paper, prepared from the original language appeared as NSA 23: 7710. (L.C.L.)

26487 AN EVALUATION OF THE APPLICATION OF BETATRONS IN THE RADIOMETRIC STUDY OF WELDED JOINTS. Berdonosov, V. A.; Vorob'ev, V. A.; Pokrovskii, A. V. Svar. Proizv., No. 11, 32-4(Nov. 1968). (In Russian).

A theoretical, technical, and economic analysis was made of a method of assessing the efficiency of radiometry in weld assessment. The method enables the productivity, time, and cost of inspection of any welded joint, to be calculated for radiometry methods and, for comparison, radiography. The results for a scintillation beta counter agree closely with production data, showing the correctness of the criteria and the method of calculation used. The method can be applied to analyze the costs of radiometric systems using different sources and gives a better basis for recommending a process for particular applications. (Metals Abstr.)

26488 SPRAVOCHNIK RENTGENO- I GAMMA-DEFEKTOSKOPISTA. (Handbook of X- and Gamma-Defectoscopic Specialists). Rumyantsev, S. V.; Shtan, A. S.; Popov, Yu. F. Moscow, Atomizdat, 1969. 276p.

The handbook covers the methods and means of defectoscopic control of materials. A brief review is given of the physical principles of radiation defectoscopy. Descriptions are given of the sources of ionizing radiation, x-ray films and amplification screens, xeroradiographic and visual methods of defectoscopy. Laboratory and safety techniques are also described. (R.V.J.)

26489 USE OF NEUTRONS IN RADIOGRAPHIC EXAMINATIONS. Diana, M. (CNEN, Casaccia, Italy); di Palo, L.; Giannini, M.; Frazzoli, F.; Ramorino, M. C.; Sciuti, S. Com. Naz. Energ. Nucl., Notiz., 15: No. 4, 46-53(Apr. 1969). (In Italian).

After reviewing the various techniques used for the application of neutrons to radiographic investigations, results obtained at the Casaccia Nuclear Research Center using the 1-MW(t) RC-1 reactor are reported. These results concern the examination of objects containing organic compounds and metals, and a natural uranium fuel element. While for the former, neutronradiography must be considered complementary to x-ray radiography, for the latter it can detect defects inside the fuel rod which could not be found by x-ray examination. (auth)

Protective Structures

26490 (EUR-4101, pp 221-49) EXPERIMENTS AND ANALYSIS ON THE PERFORMANCE OF CRUSHABLE BLAST SHIELDS. Zaker, T. A.; Lieberman, P. (IIT Research Inst., Chicago, Ill.).

Systematic experimental and analytical methods developed for evaluating the performance of blast attenuators of layered crushable materials are described. The data obtained by these methods are useful in optimizing the design of shields to contain the effects of the maximum credible explosive-like energy releases which can be associated with a reactor system. (L.C.L.)

Radioactive Material Handling

Refer also to abstracts 26357, 26413, and 26987.

26491 (BNL-50139) DISPOSAL OF SOLID WASTES GENERATED IN FLUIDIZED-BED FLUORIDE VOLATILITY FUEL REPROCESSING. Emma, L. C.; Johnson, R.; Bartlett, C.; Hatch, L. P. (Brookhaven National Lab., Upton, N. Y.). Oct. 1968. 9p. Dep. CFSTI.

In applying the fluidized-bed, fluoride volatility method for reprocessing spent reactor fuels, measures were developed for the safe and economic disposal of the wastes generated in such processes. Particular emphasis was placed on the fission product-containing aluminum oxide beds from the process reactor. Several methods were studied for treating these Al_2O_3 bed wastes in preparation for ultimate disposal by burial. Of these, dispersion of the residual bed material in glass matrices was considered the most promising. This process of fixation in a stable solid mass provided the essential property of immobility for the individual particles and their associated fission products. The end product had a relatively high thermal conductivity, which would reduce the problem of radiolytic heat dissipation in final storage. Of the several varieties of glass investigated, those of the soda-lime silicate composition appeared most suitable. These glasses combine the advantages of mechanical and chemical stability, good thermal conductivity, high fluoride retention, and low raw materials cost. The development program on disposal of volatility reprocessing wastes was directed largely toward optimization of process steps with respect both to achieving the desired quality of end product and to the practical feasibility of the process and equipment design concepts under the requirements set up for the ORNL fluidized-bed volatility process demonstration pilot plant. (auth)

26492 (CEA-R-3725) PLUTONIUM DETECTION IN CASKS OF COMPACTABLE SOLID WASTE. Fontaine, Andre; Baude, Lucette; Lafon, Helene; Eydoux, Marcel (Commissariat a l'Energie Atomique, Chusclan (France). Centre de Production de Plutonium de Marcoule). Feb. 1969. 23p. (In French). Dep.

A method for detection of plutonium in casks of compactable solid waste is described. It can be applied to amounts of plutonium varying from 2 to 200 grams. The principle of the method is the counting of the 380 keV γ photons from the plutonium-239; a correction is required if both zirconium-95 and niobium-95 are present in the cask. The maximum amount of zirconium-95 + niobium-95 which can be tolerated is 5 μCi/gr of plutonium, and 300 μCi per cask. Under the best conditions the accuracy of the measurement appears to be of the order of ±30 percent, but experience has shown that the method is very useful as a guide to the recovery of the plutonium in the waste. In effect, for a batch of fifty measurements, the difference between the plutonium measured by this method and the plutonium recovered from the waste was equal to 10 percent. (auth)

26493 (K-L-6202) FOAM PLASTIC INSULATION FOR HIGH TEMPERATURE AND SHOCK PROTECTION. Wheatley, S. J.; Mallett, A. J. (Oak Ridge Gaseous Diffusion Plant, Tenn.). [1968]. Contract W-7405-eng-26. 26p. (CONF-681127-1). Dep. CFSTI.

From International Cellular Plastics Conference, New York.

The development and testing of packages which protect cylinders of uranium hexafluoride in case of fire or accident are described. Protective packaging was accomplished with the development of a fire and shock resistant phenolic plastic foam insulation produced by mixing an organic foaming agent with a liquid phenol-aldehyde resin having a viscosity of 2,200 to 3,000 centipoises at 25°C. Two acidic agents boric anhydride (B_2O_3) and anhydrous oxalic acid ($H_2C_2O_4$) help produce a stable foam. A silicone surfactant is used to promote uniform pore size and refrigerant-113 is employed as a blowing agent. The foam is corrosion resistant to acids, oil, and water. Nuclear safety was achieved with the addition of the boric anhydride B_2O_3. (F.S.)

26494 (ORNL-TM-1312(Vol.7)) STRUCTURAL ANALYSIS OF SHIPPING CASKS. VOLUME 7. CASK TIE-DOWN DESIGN MANUAL. Evans, J. H. (Oak Ridge National Lab., Tenn.). May 1969. Contract W-7405-eng-26. 41p. Dep. CFSTI.

Analytical techniques developed to evaluate the more common types of tie-down used to secure a shipping cask to a vehicle bed during transport are presented. These frequently encountered types include the rigid or bolted tie-down of casks with rectangular and circular bases and the tension member tie-down with four-member and loggers' ties. The use of chocks to reinforce the frictional force between the cask base and the vehicle bed is treated, and various methods of attaching members to the cask and vehicle bed are discussed. (auth)

26495 ON THE INCINERATION FACILITY FOR INFLAMMABLE RADIOACTIVE WASTES. I. Muramatsu, Takio. Ehara Jiho, 17: No. 67, 47-53(Sept. 1968). (In Japanese).

An incineration facility is described and compared with similar facilities in other countries. Three years were required to complete the facility, including the affirmation with regard to the performance, heat load, radioactivity treatment, electrical dust-catcher and safety. The facility had a solid waste capacity of 10 to 20 kg/hr, including radioactive animals. It contains equipment for incineration and for decontamination of the produced gases. (NSA of Japan)

26496 PROCESSING OF RADIOACTIVE WASTE WATER FOR STORAGE AS A SOLID AT KWO. Doellgast, W.; Graemer, G.; Kausz, I.-A.; Kim, Y.-D. (Siemens AG, Erlangen, Ger.). Atomwirt., Atomtech., 14: 261-3(May 1969). (In German).

A method used at Kernkraftwerk Obrigheim for fixation of liquid radioactive wastes in sodium borate instead of more conventional materials, such as cement or bitumens, is described. This process is especially advantageous since large quantities of boric acid waste are removed from the primary loops of reactors controlled with boric acid, and since no supplementary material is required for solidifying the liquid waste. (L.C.L.)

26497 AMBITIOUS SOLIDIFICATION PROJECT AT PACIFIC NORTHWEST LABORATORY. Nucl. News, 12: No. 4, 19-21 (Apr. 1969).

High level radioactive waste solidification processes at Brookhaven National Laboratory (BNL), Oak Ridge National Laboratory (ORNL), Pacific Northwest Laboratory (PNL), Idaho Chemical Processing Plant (ICPP), Marcoule waste in France and the FINGEL process in England are briefly described and compared. The program at PNL, called the Waste Solidification Engineering Prototypes (WSEP), is explained. The facility is run as a cooperative effort of PNL, BNL, and ORNL for comparative evaluation of phosphate glass, pot calcination, and spray calcination solidification processes. WSEP will provide information to predict behavior during storage and transportation, estimate safety, predict gross process or storage conditions that affect product integrity, select a process, container, and storage media, and develop improved solidification processes and products. Studies on the phosphate glass method were completed, pot calcination work concluded, and studies on spray calcination started in April. (F.S.)

26498 STATE CONTROL OF NUCLEAR DISCHARGES? Nucl. News, 12: No. 6, 24-6(June 1969).

The problem of state control of radioactive and thermal discharges from nuclear power plants is discussed. Specifically, the standards developed by the State of Minnesota which strictly limits the kinds of radioactive and thermal wastes that the Northern States Power Company's nuclear power plant at Monticello will be able to discharge to the atmosphere and to the Mississippi River, are summarized. The permit contemplated by the Minnesota Pollution Control Agency would reduce the discharges allowed under current AEC standards by 98%. The legal implications of state actions to issue permits much more restrictive than current Federal regulations are discussed. (R.C.K.)

Vacuum Engineering

Refer also to abstract 27925.

26499 (AERE-Trans-1108) PRODUCTION OF ULTRA-HIGH VACUUM FREE OF HYDROCARBONS. Hoch, H. Translated by

C. R. Brightmore (Atomic Energy Research Establishment, Harwell, Eng.), from Vakuum-Tech., 16: [No. 7], 156-8(1967). 6p. Dep. CFSTI. UK 1s. 9d.

An abstract of this paper, prepared from the original language, appeared as NSA 21: 43220. (J.C.W.)

26500 (GEPP-61) CALIBRATION OF STANDARD LEAKS USING AN ANALYTICAL GAS MASS SPECTROMETER. Mason, T. M. (General Electric Co., St. Petersburg, Fla. Neutron Devices Dept.). Feb. 18, 1969. Contract AT(29-2)-656. 11p. Dep. CFSTI.

An analytical gas mass spectrometric method of calibrating standard leaks is discussed. This method has an estimated ±5 percent accuracy, the calibration can be completed in one day, and it has the capability of measuring active gases and distinguishing between gases in the system. (auth)

26501 APPLICATION OF CRYOGENIC PUMPS TO HIGH-VACUUM ANNEALING OF MOLYBDENUM. Azhazha, V. M.; Vasyutinskii, B. M.; Donde, A. L.; Kartmazov, G. N. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh., 14: 168-70(Jan. 1969). (In Russian).

Design and performance data for adsorption and condensing pumps capable of low-temperature screening in its active chamber are presented. Tests were made of high-temperature Mo annealing using cryogenic pumps. Tabulated data show that the thermal treatment of Mo in cryogenic pumped chamber improved the ductility of the metal. Tests with tungsten annealing in a cold carbon-free vacuum of 10^{-6} mm Hg also indicated improved ductility of the metal. (R.V.J.)

26502 WELDING OF VERY THIN FOIL. Fowler, Peter (Norton Research Corp., Cambridge, Mass.); Minges, John V. Rev. Sci. Instrum., 40: 841-2(June 1969).

Nearly ideal apertures are required for the formation of a molecular beam in a recently constructed ultrahigh vacuum calibration system. To accomplish this, it is necessary to attach a foil of thickness no greater than 0.013 mm to a massive metal flange so that the foil was planar with no wrinkles and such that a gas tight seal was formed at the circumference of the foil. The electron beam welding method, developed to satisfy these requirements, is described. (auth)

26503 SEMINAR ON ULTRA HIGH VACUUM SCIENCE TECHNIQUE AND APPLICATIONS, ESZTERGOM, HUNGARY, 2-7 OCTOBER 1967. Budapest, Eoetvoes Lorand Physical Society, 1967. 525p. (CONF-671080).

Thirty-eight papers were presented at the conference. The papers covered are phases of ultrahigh vacuum technology, e.g., production of UHV, pumping systems, vacuum pumps and gages, pressure measurement, and gas desorption from metals. (R.C.K.)

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstract 26189.

General Detectors and Monitors

Refer also to abstracts 26475, 27703, 27704, 27908, and 28300.

26504 (AD-677011) CHARGE COLLECTION EFFICIENCIES FOR LITHIUM-DRIFTED SILICON AND GERMANIUM DETECTORS IN THE X-RAY ENERGY REGION. Zulliger, H. R.; Aitken, D. W. (Stanford Univ., Calif. High-Energy Physics Lab.). Feb. 1968. Contract AF49(368)-1499. 19p. (AFOSR-68-1676). CFSTI.

Theoretical calculations showing the charge collection efficiencies of Ge (Li) and Si (Li) planar detectors as a function of trapping lengths and incident x-ray energies are presented. It is demonstrated that there should be an intrinsic energy dependence of the charge collection efficiency for radiation lengths comparable to the detector depletion depth. The nonlinear behavior is generally greater for unequal hole and electron trapping lengths. Experimental results confirm this in part, but surface effects appear to accentuate the effect. It is concluded that, neglecting surface effects, the nonlinearities should be eliminated if the radiation is incident in a direction perpendicular to the field. Highest charge collection efficiency, best resolution and linearity are obtained by injecting the photons through the detector side (perpendicular to the field) along a unique plane which is defined by the electron to hole trapping ratio. (auth) (USGRDR)

26505 (AD-678581) MEASUREMENT OF X-RAY PULSES BY CHEMICAL MEANS. Klein, Nathan; Fanning, James E. Jr.; Smith, Thomas L. (Army Nuclear Defense Lab., Edgewood Arsenal, Md.). Sept. 1968. 41p. (NDL-TR-115). CFSTI.

This report describes a technique for measuring the size and shape of an x- or gamma-ray pulse. The technique is based on water and dilute aqueous solutions that, when irradiated, produce the hydrated electron, e (aq) (-), a short-lived, transient ion with an intense optical absorption spectrum. Measurements of the intensity of red light transmitted through the irradiated sample are directly correlated to radiation intensity. Resolving time of the system is in the nanosecond range. The technique is shown to be feasible and may have application at pulsed accelerator facilities and at nuclear weapons tests. (auth) (USGRDR)

26506 (AD-678920) EVIRONMENTAL RESEARCH SATELLITE-18 DATA REDUCTION AND ANALYSIS. VOLUME I. SATELLITE DESCRIPTION AND OPERATIONS. Terminal Flight Report. Peterson, Laurence E.; Gruber, Duane; Lewis, Stephen J.; Stone, Michael R.; Vette, James I. (California Univ., La Jolla, San Diego). July 1968. Contract F04701-68-C-0108. 71p. (UCSD-SP-68-5). CFSTI.

The 17.2 lb Environmental Research Satellite-18 (ORS-III-B) carried a set of five radiation detectors designed to measure charged particles, x-rays, gamma rays, and cosmic rays in the near-Earth environment. (auth) (USGRDR)

26507 (AERE-M-1838) BETA-GAMMA COUNTING SYSTEM FOR 2000 SERIES. Witsey, K. (Atomic Energy Research Establishment, Harwell (England)). Dec. 1968. 29p. Dep. CFSTI. UK 5s. 0d.

A system is described for coupling G.M. detectors into the 2000 Series unitized system, comprising a head unit which is mounted close to the detector, used in conjunction with one of two adaptors. The head unit generates a fast quench pulse (2.5 volts/nanosecond) and is mounted close to the detector to minimize stray capacitance. High voltage supplies for the detector and the head unit are provided by the adaptors. A system for low background beta-gamma counting using a Van Duuren anti-coincidence detector is also described. (auth) (UK)

26508 (AERE-R-5991) ASSESSMENT OF A LOW-PRESSURE CLOUD CHAMBER FOR RANGE MEASUREMENTS OF LOW-ENERGY ELECTRON TRACKS. Delafield, H. J. (Atomic Energy Research Establishment, Harwell (England)). Dec. 1968. 36p. Dep. CFSTI. UK 5s. 6d.

An investigation was carried out into the potentialities of a low pressure cloud chamber for measuring the energy deposition by ionizing particles of low energy. This information is required for a fuller understanding of the relationship between radiobiological effect and radiation quality. The construction and operation of a small cloud chamber is described, and its performance assessed using an α-source and 1.5 keV characteristic x rays, down to a pressure of about 10 cm Hg. These studies have shown that it should be possible under these conditions to measure the penetration ranges of electrons down to about 1 keV, but that individual droplets cannot be readily resolved. Difficulty was experienced in expanding the chamber with sufficient precision to control the rapid diffusion of ions during the initial stage of droplet growth. The diffusion could be better controlled by an improved expansion mechanism, but the ultimate performance would be limited by the optical resolution of the system. It would be possible to resolve the details of the tracks of particles whose LET did not exceed 10 keV/micron in unit density material. (auth) (UK)

26509 (BMwF-FBK-69-6) INVESTIGATION OF TEMPERATURE, PRESSURE, AND RADIATION RESISTANT SEMICONDUCTOR PROBES FOR REACTOR IN-CORE APPLICATION. Graul, J.; Ruge, I. (Technische Hochschule, Munich (West Germany). Institut fuer Technische Elektronik). Feb. 1969. 52p. (In German). Dep.

Semiconductor materials which meet the requirements for reactor in-core application (i.e., possess low neutron cross section and good temperature stability) are discussed. The radioactivity due to nuclear transmutation in these materials is calculated as are the number of Frenkel defects which may be expected from neutron, gamma, and alpha irradiation. For silicon carbide, at present one of the most promising semiconductor materials for reactor application, there is given a short review of preparation techniques, electrical properties, doping and etching processes. Radiation-induced currents in silicon carbide pn junctions are examined experimentally and theoretically. Suggestions are made for the development of a radiation-resistant neutron probe using polycrystalline silicon carbide Schottky barriers covered by a double layer of boron and iridium for neutron-α particle conversion. The signal amplitude induced by reactor neutron flux in such a probe is estimated. (auth)

26510 (CEA-R-3624) TELESCOPE FOR STUDYING CHARGED PARTICLES PRODUCED BY 14 MeV NEUTRONS. Mouilhayrat, Guy (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). 1969. 64p. (In French). Dep.

Thesis. Submitted to Univ., Paris.

A telescope using semiconductor detectors for studying the charged particles produced in a thin radiator by 14-MeV neutrons were developed. It consists of a proportional CO_2-counter and two cooled semiconductor detectors (one of the $\Delta E/\Delta x$ type, the other of the E type). This low-noise telescope has good energy resolution (370 keV). Used in conjunction with a biparametric recording ($\Delta E - E$) it gives a satisfactory identification and discrimination of the charged particles (p,d) detected. This telescope has been used to observe the spectrum of protons from the reaction D(n,p)2n emitted at 0° ($E_n = 13.9$ MeV) in the energy range 4-14 MeV. (auth)

26511 (IS-T-296) PREPARATION OF PLANAR LITHIUM-DRIFTED GERMANIUM DETECTORS. Jackson, Glen L. (Ames Lab., Iowa). Feb. 1969. Contract W-7405-eng-82. 62p. Dep. CFSTI.

Thesis.

Lithium has been drifted into germanium using both boiling-liquid and plate-type drift apparatus. Both methods have been investigated at two temperatures, the 320.8°K boiling temperature of Freon 113 and the 297°K boiling temperature of Freon 11. It was found that the lithium drift rate was closer to the theoretical value at the higher temperature than it was at the lower temperature. The drift rate should be closer to the theoretical value at the higher temperature because the solubility of lithium in germanium rises with temperature. In one plate-type drifter the temperature and drift voltage were maintained constant, but the drift current varied. In the other plate-type drifter the drift voltage and drift current were maintained constant, but the temperature varied. Both plate-type drifters allowed lithium to be drifted into germanium to a depth of 5 mm, but the leakage current of 20 mA for the constant-voltage, constant-current process was much less than the leakage current for the constant-temperature, constant-voltage process. (auth)

26512 (KFK-860) A MONTE-CARLO PROGRAM FOR RECOIL PROTON COUNTERS WITH CYLINDRICAL GEOMETRY. Brandl, V. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Oct. 1968. 30p. (In German). (EUR-4154). Dep.

The principles and the description of a Monte-Carlo program for the IBM-7074 for the evaluation of neutron spectrum measurements with proton-recoil counters were presented. The method for the evaluation of neutron spectrum measurements is based on the fact that one can with the help of the recoil-proton spectrum measurements calculate the actual recoil proton spectrum. In the development of the program the following simple assumptions were made: the collision sites in the cylindrical counter are equally distributed, each neutron collides in the cylinder only once, and the angular distribution of the recoil protons is isotropic in the center of gravity system. The program permits the calculation of the spectra for neutron incidence parallel to the cylinder axis and for isotropic neutron fluxes. The results of some calculations with varied input parameters were given. (J.S.R.)

26513 (N–69–11258) LTV BETA–BREMSSTRAHLUNG SPECTROMETER FOR GEMINI 12. Final Report. Farmer, B. J.; Chappell, N. E.; Bagwell, R. G.; Rainwater, W. J. (LTV Research Center, Dallas, Tex.). Mar. 1967. 153p. (NASA-CR–92384). CFSTI.

Design and operation of a combination beta bremsstrahlung spectrometer and onboard data processor for Gemini XII is discussed. This instrument is mounted inside the spacecraft and monitors both electrons and x-rays simultaneously. It combines the application of a complex scintillation crystal assembly with high speed electronic circuitry to identify and separate the two radiations from a mixed field. Flight data obtained by this system will be used to determine the spectra of radiation outside the spacecraft and the physical dose due to those radiations inside with their relative intensities after penetration. (STAR)

26514 (N–69–14028) RESPONSE OF THE ION–ELECTRON DETECTOR FLOWN ON EXPLORER 12, AUGUST–DECEMBER 1961. Davis, Leo R.; Konradi, Andrei (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Nov. 1968. 520p. (NASA-TM-X–63407; X–612-68-447). CFSTI.

Graphs are presented to depict the temporal history of the output of the ion–electron detector flown on Explorer 12. The satellite was launched on August 16, 1961, and ceased transmitting on December 6, 1961. It had a 33° inclination orbit with an apogee at 13 R_e which permitted it to cross the boundary of the magnetosphere twice on each orbit. Its orbital period was 26½ hours. At launch the line of apsides was pointed in the direction of the Sun. The detector was a scintillation counter consisting of a photomultiplier tube on the face of which is deposited a 5-mg/cm^2-thick layer of crystalline ZnS covered by a 1000 Å thick layer of Al. (auth) (STAR)

26515 (N–69–17998) GAMMA-RAY TELESCOPE UTILIZING LARGE AREA WIRE SPARK CHAMBERS. Ross, R. W.; Ehrmann, C. H.; Fichtel, C. E.; Kniffen, D. A.; Oegelman, H. B. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Nov. 1968. 13p. (NASA-TM-X–63416; X–611-68-443). CFSTI.

A second generation gamma-ray telescope has been developed for further experiments in balloon-borne astronomy. This instrument is composed of 32 wire-grid spark chamber modules, each 50×50 cm^2, utilizing two-coordinate ferrite core readout. The detector is flown on a 27 million cubic foot research balloon in a search for discrete gamma-ray sources and supernovae explosions. (auth) (STAR)

26516 (N–69–18111) COMPUTER ANALYSIS OF TRACKS IN NUCLEAR EMULSION UTILIZING DIGITIZED VIDEO SCAN. Ehrmann, C. H.; Reames, D. V. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Nov. 1968. 15p. (NASA-TM-X–63405; X–611-68-438). CFSTI.

A system has been developed to make density measurements on particle tracks in nuclear emulsions. The output signal of a videcon viewing the track through a microscope is digitized to detect developed grains in the emulsion. This digitized information is transferred in real time to a computer which selects grains falling in the track and sums their volumes and computes parameters related to their spatial distribution. Analysis of tracks at arbitrary angles is accomplished by rotating the track image in the focal plane with a Pechan prism and by driving the focal plane through the emulsion while taking data. (auth) (STAR)

26517 (RT/FI–(69)-9) FISSION MICRO-CHAMBERS. Balducci, G.; Martini, M.; Vigo, A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1969. 33p. Dep.

The construction and use of pulse-type and mean current-type fission microchambers to be employed in subcritical facilities and in power reactors are discussed. (auth)

26518 OPERATION OF SURFACE-BARRIER SILICON DETECTORS UNDER 10 TO 70 keV PROTON IRRADIATION. Bogdanov, G. F.; Maksimenko, B. P. At. Energ. (USSR), 26: 252-6(Mar. 1969). (In Russian).

A study was made of the amplification factor, capacity, reverse current, and FWHM of surface barrier silicon detectors during irradiation by protons with 10 to 70 keV energies. The build up factors for most shielding materials were counted. The calculated and experimental data are in good agreement. B_n^{dose} experimental values were obtained during experiments in a water cooled and moderated reactor. B_n^{dose} for some materials as a function of their properties, thickness and arrangement relative to the neutron source is illustrated. The method permits to define most "dangerous" regions of the shield from the view point of slowing down neutron build-up. It is also valid for determining shield optimal compositions. (9 figures, 19 references.) (auth)

26519 AN EXPRESSION FOR MINIMUM-TIME RESOLUTION IN SCINTILLATION DETECTORS. El-Wahab, M. A.; El-Salam, M. A.; Sakka, M. (Alexandria Univ., Egypt). Nuovo Cim., Suppl., 6: 1411-13(1968).

In a previous paper by the authors (Nucl. Instr. and Meth. 59, 344(1968)) the light output of the scintillator and the photocathode-first dynode transit time jitter were introduced as experimentally shaped probability-density functions whose fluctuations follow normal statistics, and the fwhm are calculated directly without drawing the p.d. curves. In the model presented a nonfixed zero point of time, i.e., the time interval for the single-electron response function is extended to $(-\infty \leq t \leq +\infty)$ is assumed. (B.G.D.)

26520 WILSON CLOUD CHAMBER FOR THE STUDY OF THE (n,α) REACTION. Hsu, Yuin-chi; Huang, Chia-yi; Lin, Song-yun; Chou, Muh-chuen; Hsu, Yi-chuann (National Taiwan Univ., Taipei). Chin. J. Phys. (Taiwan) 6: 119-22(Oct. 1968).

Wilson cloud chamber of 40 cm diameter and 20 cm height is used to study the (n,α) reactions. In order to get sharp tracks, the neutron generator works as pulsed source synchronized to the sensitive time of the cloud chamber. The expansion valve and the control circuit system for the operation of the chamber are described in detail. (auth)

26521 RADIATION DETECTOR AND AMPLIFIER. (to Bendix Corp.). British Patent 1,145,805. Mar. 19, 1969. Priority date July 14, 1966, United States.

A radiation detector and amplifier device is described comprising a tubular channel having an input, an output and having a continuous inner secondary electron emissive and resistive surface. The walls of the channel are adapted to carry a current flow creating inside the channel an electric accelerator field parallel to the longitudinal dimension of said channel. A slot is formed in the wall of said channel at its input end, which is essentially parallel to the channel axis. The slot has a dimension parallel to the channel axis which is substantially larger than the dimension which is transverse to the channel axis for receiving a narrow beam of radiation energy. It also includes means for confining said tubular channel in an evacuated environment. (auth)

26522 THEORY OF ANISOTROPY IN RADIOLUMINESCENCE. Luntz, Myron. Storrs, Conn., Univ. of Connecticut, 1968. 189p.

Thesis.

The interaction between energetic heavy ions (^{4}He, ^{10}B, ^{11}B, ^{12}C, ^{14}N, ^{16}O, ^{19}F, and ^{20}Ne) of energy to mass ratio ranging from 1–10 MeV/amu and the constituents of NaI(Tl) and CsI(Tl) single crystals is treated, for particle incidence along the crystal channels NaI⟨100⟩, NaI⟨110⟩, CsI⟨111⟩ and CsI⟨100⟩, for the purpose of obtaining a prediction of the luminescent response to the channeled particles and thus a quantitative explanation of an observed anisotropy in the scintillation spectrum for CsI(Tl), reported by a Yale University group. The anisotropy is attributed qualitatively to the combined effect of channeling and the saturation of scintillation efficiency (dL/dE) for high specific energy loss (–dE/dx). It is assumed that channeled particles, due to their anomalously low rate of energy loss, tend not to saturate the scintillation efficiency and thus induce a brighter than normal response. An analytic expression for the specific energy loss of the "best" channeled particles is obtained. To this end, an existing electron-gas model is applied to a treatment of the excitation of valence electrons, and an additional term is constructed which accounts for core-electron excitation. Non-participating electrons are identified by application of an adiabaticity criterion and are excluded from all stopping power considerations. The particle trajectories are taken to lie directly along the channel axes. The stopping powers calculated for the various channeled particles are typically 20% to 25% of the stopping power characteristic of random incidence, in contrast to experimental stopping power ratios of 33% for well channeled protons in germanium, and approximately 50% for protons in silicon, thus indicating that channeling effects in the alkali iodides are relatively pronounced.

The contributions of core excitation to the stopping power of the various channels for the heavier particles range, on the average, up to approximately 20% of the total. In contrast, the lightest particle considered, ^{4}He, is found to induce a negligible amount of core excitation, similar to that observed experimentally for protons of MeV energies incident on silicon. The resulting stopping power curves (dE/dx vs. E) for the "best" channeled particles are combined with the Yale scintillation efficiency data (dL/dE vs. dE/dx) for NaI(Tl) and CsI(Tl), under the assumption that the dependence of scintillation efficiency on specific energy loss is the same for channeled as for randomly incident particles. A discussion of this assumption is presented. The luminescent response to channeled particles is found to be linear. High velocity channeled particles in NaI(Tl) (E/A = 10 MeV/amu) are predicted to induce approximately 34% greater light output than randomly incident particles; and in CsI(Tl) approximately 24%. Limiting angles of incidence (acceptance angles) for channeling, and thus for a brighter than normal scintillation response, and obtained using existing channeling theory. The alkali-iodide channels are found to be considerably more open, in terms of acceptance angle, than are the axial channels in silicon or germanium. (Disser. Abstr.)

26523 CONTROL UNIT FOR AUTOMATICALLY RECORDING MOESSBAUER SPECTROMETERS. **Shideler, J. A.; Terry, C. (Univ. of Wyoming, Laramie). Nucl. Instrum. Methods, 70: 233-4(Apr. 15, 1969).**

A method is described which allows the accumulation of data for a single Moessbauer spectrum in the total available channels of a multichannel analyzer. (auth)

26524 SCINTILLATION LIGHT YIELD OF THIN FILMS OF ANTHRACENE. **Boensch, G.; Kleinert, G.; Flammersfeld, A. (Univ., Goettingen, Ger.). Z. Phys., 222: 363-71(1969). (In German).**

Thin films of anthracene were produced by evaporation on substrates cooled by liquid air. Fluorescence spectra and x-ray diffraction diagrams indicate a new crystalline phase of anthracene. With increasing temperature this modification shows an irreversible transition into normal polycrystalline anthracene. The scintillation light yield produced by α-particles and electrons is strongly reduced as compared to normal anthracene. (auth)

26525 GAMMA RAY MEASUREMENT WITH CERENKOV DOSE RATE METERS. **Aiginger, Hannes; Tschirf, Erich (Atominstitut der Oesterreichischen Hochschulen, Vienna). Atomkernenergie, 14: 182-4(1969). (In German).**

Two different types of Cherenkov-detectors for gamma-dose rate measurements are described. Curves are given for the sensitivity, the energy-responsibility and the relationship of photoelectric current and dose rate at high intensities. (auth)

26526 EXPERIENCES WITH METHANE GAS FLOW COUNTERS USED FOR ENVIRONMENTAL SURVEY OF REACTOR PLANTS. **Pusch, W. M. (Oesterreichischen Studiengesellschaft fuer Atomenergie, GmbH, Vienna). Atomkernenergie, 14: 189-97(1969). (In German).**

Samples which are taken to survey the radioactivity in the surroundings of a reactor plant are very different in their quality from these which are ideally suited for measurement in a windowless gas flow counter. The many sources of error in the measured activity are discussed in this work. The disadvantages of a windowless gas flow counter can be avoided by sealing the window of the counting tube with a very thin but elastic foil. Foils only 0.02 mg/cm^2 thick were used so that absorption in them can be neglected even for very weak radiation. Production of these foils is described. The foil is fixed to a cathode lattice, by which the electrical field in the counting tube is shielded against the sample. Furthermore some results obtained with common methane gas flow counters are given. A scintillation counter with a plastic phosphorus detector from which the aluminum can was removed was considered (its efficiency was greatly increased because of the lack of absorption in the foil). Such a scintillation probe must be used in lighttight lead shielding, but shows approximately the same efficiency as a function of β-energy as an ancient type of gas flow counter. (auth)

26527 VIAL CONSTRUCTIONS FOR USE IN STANDARDIZATION PROCEDURES INVOLVING LIQUID SCINTILLATION SPECTROMETRY EQUIPMENT AND HAVING A SEPARATE COMPARTMENT FOR AN INTERNAL STANDARD RADIATION SOURCE. **Packard, Lyle E. (to Packard Instrument Co., Inc.). U. S. Patent 3,437,812. Apr. 8, 1969. Filed June 8, 1965.**

An improved sample vial is described for use in transporting discrete test samples including a liquid scintillator and a radioactive isotope to and from a radiation detection station adapted to produce output signals in response to detection of light scintillations occurring in the liquid scintillator. The sample vial comprises a receptacle formed of light transmissive material for receiving and storing a quantity of the liquid scintillator and the radioactive isotope to be analyzed, and a removable closure for closing the receptacle. The vial also includes a compartment having its interior portions spaced away from any liquid scintillator contained within the receptacle so as to permit reception and normal maintenance of a solid standard radioactive source of radiation having relatively low penetrating power in spaced proximity to the liquid contained within the receptacle. Means are provided for permitting the standard radioactive source to be automatically discharged from the compartment into the liquid receptacle. (auth)

26528 RESOLUTION EFFECT IN THE GAMMA-NEUTRINO ANGULAR CORRELATION EXPERIMENT. **Pratt, T. A. E. C. (Hampton Inst., Va.). Nucl. Instrum. Methods, 70: 213-17 (Apr. 15, 1969).**

A procedure for understanding the resolution effect in the gamma-neutrino angular correlation experiment is discussed. It emphasizes the importance of the energy calibration of the detection system or multichannel analyzer. It is shown that information about the range effect in the gamma-neutrino angular correlation experiment could be extracted easily from the Doppler gamma spectrum. (auth)

26529 EFFECT OF UNDEPLETED REGION UPON DOPPLER-BROADENED LINE SHAPE FOR Ge(Li) DETECTORS. Roush, M. L.; Connors, P. I. (Univ. of Maryland, College Park). Nucl. Instrum. Methods, 70: 218-20(Apr. 15, 1969).

Line shapes observed with a coaxial Ge(Li) detector are affected by the presence of the undepleted core when the γ-ray energy varies with position across the face of the detector. (auth)

26530 PULSE SHAPE CHARACTERISTICS OF A Ge(Li) DETECTOR STUDIED WITH A COLLIMATED GAMMA-RAY BEAM. **Schmidt-Whitley, R. D. (Univ., Erlangen, Ger.). Nucl. Instrum. Methods, 70: 227-32(Apr. 15, 1969).**

A rectangular Ge(Li) detector drifted from five sides is investigated with a collimated beam of gamma-rays. The pulse rise shape distributions and their influence on coincidence timing are discussed. (auth)

26531 USE OF VANADIUM SCATTERING TO INTERCALIBRATE AN ARRAY OF THERMAL NEUTRON DETECTORS. **Day, D. H.; Johnson, D. A. G.; Sinclair, R. N. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Instrum. Methods, 70: 164-8(Apr. 15, 1969).**

Thirty-two lithium-glass scintillation detectors are intercalibrated by scattering thermal neutrons nearly isotropically using various vanadium samples. The experimental problems of the method are discussed and the results compared with those calculated from theory. (auth)

26532 SENSITIVITY ENHANCEMENT OF LEXAN NUCLEAR TRACK DETECTOR. **Benton, E. V.; Henke, R. P. (Naval Radiological Defense Lab., San Francisco). Nucl. Instrum. Methods, 70: 183-4(Apr. 15, 1969).**

Ultraviolet radiation in the presence of oxygen has been used to greatly enhance track-etching rates in Lexan polycarbonate nuclear particle track detectors. When irradiated detectors are stored in darkness, the slow variation of chemical track reactivity in Lexan with the age of latent tracks can be explained as being caused by the presence of oxygen. (auth)

26533 RADIATION DETECTORS HAVING A SEMICONDUCTOR BODY. **Meuleman, J. (to N. V. Philips' Gloeilampenfabrieken). Canadian Patent 805,841. Feb. 4, 1969. Priority date July 1, 1965, France.**

The detector has an inversion layer which is covered with palladium oxide, and the semiconductor body consists of n-type conductive silicon. The method of manufacturing the instrument is described. (CANADA)

26534 DELAY MATCHING OF BETA–GAMMA COINCIDENT PULSES. **Munzenmayer, K.; Baerg, A. P. (National Research Council, Ottawa). Nucl. Instrum. Methods, 70: 157-63(Apr. 15, 1969).**

The time-jitter of β−γ coincidence pulse pairs is examined in terms of their time-order of appearance at the coincidence gate. The relative channel delays may be set to a preferred mean zero value by adjusting for near-equal β- and γ-coincidence gating frequencies. A gating analyzer for this application is described in detail. (auth)

26535 ELECTRIC FIELD PROFILE AND ELECTRON DRIFT VELOCITIES IN LITHIUM-DRIFTED SILICON. **Zulliger, H. R. (Stanford Univ., Calif.); Norris, C. B.; Sigmon, T. W.; Pehl, R. H. Nucl. Instrum. Methods, 70: 125-33(Apr. 15, 1969).**

The electric field profile and the drift velocity of electrons in lithium drifted silicon in the ⟨111⟩ direction at room temperature have been measured. By injecting short bursts of 10 keV electrons into reverse biased diodes, current pulses were produced and viewed on a sampling oscilloscope. To improve the accuracy of the measurement, a picosecond signal averaging system was employed. Electric field profiles in thin Si(Li) showed an over compensation of the p material near the n^+ contact, probably due to the lithium diffusion process. Drift velocity measurements as a function of electric field over the range from 2.0 to 48 kV/cm were obtained. At 48 kV/cm, the drift velocity of 8.6×10^6 cm/sec is not yet a saturation value. (auth)

26536 METHOD AND APPARATUS FOR DOSIMETRIC MEASUREMENT OF RADIATION. **Price, P. B.; Walker, R. M. (to General Electric Co.). Canadian Patent 803,628. Jan. 7, 1969.**

A device is described which consists of a thin sheet of glass or mica containing a minute amount of fissionable material and a strip of cadmium foil for measuring radiation at extremely high levels such as nuclear explosions or operating reactors. After exposure, there is a process of dissolving and removing from the sheet fission fragment damage "track-defining" material and thereafter determining the number of recesses formed in the sheet by optical microscope counting. Fast and thermal neutron radiation can be detected up to a factor of 10^{15} and from room temperature to 600°C. An accurate readout is obtained from the fission product tracks. (CANADA)

26537 ROCKET-BORNE dE/dxE SEMICONDUCTOR DETECTOR TELESCOPE FOR PARTICLE IDENTIFICATION. **Doke, Tadayoshi; Nagata, Katsuaki; Nakagawa, Shigeo; Sasaki, Akira; Tsukuda, Masahiro (Tokyo Univ.). Inst. Space Aeronaut. Sci., Univ. Tokyo, Rep. No. 426: 193-207(July 1968).**

A semiconductor dE/dx E telescope was used for identification of protons, deuterons, and tritons in the Van Allen belt and heavy charged particles including ^{12}C and ^{13}C in primary cosmic rays. Basic considerations for particle identification over broad energy range and limitations of isotope identification in heavy charged particles are discussed. General design principles of the detector telescope, including the characteristic of the transmission type detectors, are presented. Three rocket experiments were carried out to measure hydrogen isotope abundance in the Van Allen belt. L-3H type sounding rockets were launched from the Kagoshima Space Center (131°05′E, 31°15′N) from March 1966 to February 1967. The L-3H-2 rocket attained a maximum altitude of 1800 Km. All the electronic instruments performed perfectly. The variation of proton counting rate with flight time of the rocket is illustrated. The marked increase in the counting rate about 8 min after the launch of the rocket clearly showed the beginning of the Van Allen belt. The rate rapidly reached its maximum value at 12 min and remained constant until 18 min when it again began to decrease, while the rocket reached the maximum altitude of 1800 Km at 14 min 45 sec. The total counts of protons during the entire flight was 48,000, of deuterons only 4, and of tritons and heavier particles 6. The abundance ratio for deuteron/proton and triton/proton in the Van Allen belt was 0.8×10^{-4} and 1.2×10^{-4} respectively. (BBB)

26538 SCINTILLATION COUNTER FOR CONTINUOUS MONITORING OF RADIOACTIVITY IN SOLUTIONS. **Clifford, K. H.; Hewett, A. J. W.; Popjak, G. (Shell Research Ltd., Sittingbourne, Eng.). J. Chromatogr., 40: 377-85(Apr. 8, 1969).**

A scintillation counter, suitable for the measurement of radioactivity in solutions irrespective of the nature of the solvent, is described. The instrument has been developed specifically for the continuous monitoring of effluents from chromatographic columns. Beads of a lithium–cerium glass, insoluble in all solvents except hydrofluoric acid, in a shallow flow-cell act as scintillator; the photons are detected with a pair of photomultipliers with coincidence circuit in conjunction with a ratemeter. The efficiency of counting ^{14}C and ^{35}S in solution is better than 20%; for ^{32}P the efficiency is about 90%, for ^{36}Cl 63%, but for ^{3}H it is only 0.3%, depending on photomultiplier and discriminator voltages and temperature selected. (auth)

26539 X-RAY OPTICS AND X-RAY ASTRONOMY. **Kantor, Frederick W. (Unified Tech., Inc., New York). Trans. N. Y. Acad. Sci., 30: 1100-11(June 1968).**

Three new instruments for x-ray astronomy are described briefly, as is the possible application of x-ray optics to high resolution mask-making for semiconductor production. First is the large-area x-ray collector, in which the mechanical constraints of surface smoothness, for efficient reflection, and of surface orientation, for focusing, are separated; this separation makes feasible focusing devices with an effective area of several square meters and the focusing both of photons with energy from ~0.1 to ~20,000 eV and of subthermal neutrons. Second is a matrix detector for ionizing radiation, suitable for use in the focal plane of a collector, with spatial resolution of a few millimeters, an overall quantum efficiency of greater than 75%, and energy resolution. Third is an inflatable gas counter, suitable for automatic erection in space. (BBB)

26540 REACTION INDEPENDENT ANALYSIS OF GAMMA RAY ANGULAR DISTRIBUTIONS FROM Ge(Li)-DETECTOR MEASUREMENTS. **Scott, H. L.; Horoshko, R. N.; Van Patter, D. M. (Franklin Inst., Swarthmore, Pa.). Nucl. Instrum. Methods, 70: 320-4(May 1, 1969).**

Reaction-independent analysis of particle γ-angular correlations from aligned nuclei involves particle detection near 0° or 180°, and is generally limited by the energy resolution of the particle counter if a NaI(Tl) counter is used to detect the γ-rays, and by the relatively low coincidence rates if a Ge(Li) counter is used. Under certain circumstances, an alternative method, which does not require particle γ-coincidences, is the simultaneous analysis of the angular distributions for two or more γ transitions from the same nuclear state. High resolution angular correlation information can thus be obtained using a Ge(Li) detector. Angular distribution data for several spin-2 levels in ^{42}Ca and ^{58}Ni serve as illustrations of this method. It is shown that E2/M1 mixing ratios for 2 → 2 transitions can be evaluated with an accuracy comparable to particle-γ or γ-γ angular correlation measurements. (auth)

26541 MONTE CARLO CALCULATED EFFICIENCY OF NaI(Tl) DETECTORS IMBEDDED INTO (OR EXTERNAL TO) CYLINDRICAL SOURCES. **de Franceschi, L.; Pagni, F. (CAMEN, Pisa, Italy). Nucl. Instrum. Methods, 70: 325-30 (May 1, 1969).**

The theoretical evaluation of absolute detection efficiency of a cylindrical scintillation gamma-ray detector imbedded into or external to a coaxial cylindrical gamma-source is studied. The calculation was carried out by a Monte Carlo method for gaseous or aqueous sources of several sizes (their volumes ranging between a few liter and a few m^3) and several gamma-energies (between few keV and few MeV), and for two different sizes of the detector (2″ × 2″ and 1″ × 1½″). Experimental measurements were made where possible, especially with liquid sources, and results were successfully compared with computed data. (auth)

26542 A MONTE CARLO METHOD FOR PERFORMING DIFFICULT GEOMETRY SOLID ANGLE CORRECTIONS. **Cox, B. (Army Nuclear Defense Lab., Edgewood Arsenal, Md.). Nucl. Instrum. Methods, 70: 340-2(May 1, 1969).**

A general prescription for calculating by means of a Monte Carlo technique the solid angle corrections for finite source, finite detector and non trivial relative geometry situation has been outlined. A specific application of this technique is presented. (auth)

26543 PULSE HEIGHT ANALYZER AND ASSOCIATED THRESHOLD DETECTION AND LOGIC CIRCUITRY FOR GENERAL SATELLITE APPLICATION. **Cancro, C. A.; Garrahan, N. M. (Goddard Space Flight Center, Greenbelt, Md.). Nucl. Instrum. Methods, 70: 245-52(May 1, 1969).**

A pulse height analyzer and its associated threshold detection and logic circuitry, developed for general satellite application, is described. The analyzer has a capacity of up to 512 channels and will accept signals from scintillating crystal, solid state and proportional counter detectors having rise times in the range 200 nsec to 2.0 μsec. The threshold detectors and logic circuitry may be used to determine coincidence and anti-coincidence of detector inputs and for selecting events. The circuitry was designed to minimize power drain, weight and volume and to exhibit a high level of reliability while operating in the temperature range −20°C to 60°C. The basic circuitry has operated successfully in the instrumentation system for cosmic ray experiments on the Explorer 34 satellite. (auth)

26544 A SEMI-EMPIRICAL EFFICIENCY CURVE FOR A Ge(Li) DETECTOR IN THE ENERGY RANGE 50 TO 1400 keV. **Mowatt, R. S. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucl. Instrum. Methods, 70: 237-44(May 1, 1969).**

A semi-empirical method is given to obtain the relative full-energy-peak efficiency ϵ_γ of a Ge(Li) diode over the γ-ray energy range 50 to 1400 keV. The method is an extension of the work done by Freeman and Jenkin and accounts for both γ-ray attenuation in the materials present between a fixed source position and the intrinsic region of the diode and the saturation of the diode efficiency at low energies. The formula was fitted to the observed relative efficiency of a 2 mm depleted Ge(Li) planar diode to an accuracy of 1½% over the range 100 to 1400 keV and 4% over the range 50 to 1400 keV. The dependence of the shape of the relative efficiency curve on source-to-diode distance was examined using a ^{169}Yb point source. (auth)

26545 ELECTRONIC ELIMINATION OF RADIATION PICK-UP DUE TO SPARK CHAMBER DISCHARGES. **Agrawal, P. C.; Damle, S. V.; Kamat, A. P.; Kunte, P. K.; Ramchander, S. R.; Srinivasan, K. V. (Tata Inst. of Fundamental Research, Bombay). Nucl. Instrum. Methods, 70: 298-300(May 1, 1969).**

A simple method of electronically eliminating radiation pick-up due to spark chamber discharges, in the electronic logic of a counter telescope, is described. (auth)

26546 USE OF CELLULOSE NITRATE PLASTIC IN THE STUDY OF BLOCKING IN SINGLE CRYSTALS. **Marsden, D. A.; Johansson, N. G. E.; Bellavance, G. R. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucl. Instrum. Methods, 70: 291-7(May 1, 1969).**

Cellulose nitrate plastic has been used to record permanent track patterns of alpha particles backscattered from various single crystals. These patterns show the orientation of the crystal surface and give quantitative information about the blocking phenomenon. The technique is shown to be useful in aligning single crystals (particularly in the "double alignment" type of experiment), and for the examination of crystal surfaces. This technique also holds promise for the study of the (p,α) reaction in aluminium single crystals, where the alpha particle yield is difficult to observe in the presence of a preponderance of scattered protons. (auth)

26547 CHARACTERISTICS OF ION-IMPLANTED CONTACTS FOR NUCLEAR PARTICLE DETECTORS. II. CONCENTRATION DISTRIBUTION IN ION-IMPLANTED CONTACTS FOR SEMICONDUCTOR DETECTORS. **Meyer, O. (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Instrum. Methods, 70: 285-90(May 1, 1969).**

An analytical treatment is given which allows the calculation of the depth concentration of electrically active centers in ion-implanted contacts, starting from the measured dependence of the window thickness on reverse voltage. The influence of the following parameters on the depth distribution is studied: dopants, ion energy, ion concentration, doping concentration of the base material, crystal orientation, and annealing temperature. By variation of the doping concentration of the base material it is possible to determine the concentration distribution over four orders of magnitude. The minimum detectable concentration is about $10^{12}/cm^3$. The results are related to other observations obtained in measuring concentrations profiles by different methods. (auth)

26548 CHARACTERISTICS OF ION-IMPLANTED CONTACTS FOR NUCLEAR PARTICLE DETECTORS. I. WINDOW THICKNESS OF ION-IMPLANTED SEMICONDUCTOR DETECTORS. **Meyer, O. (Kerforschungszentrum, Karlsruhe, Ger.). Nucl. Instrum. Methods, 70: 279-84(May 1, 1969).**

The thickness of the entrance window of ion-implanted semiconductor counters was experimentally studied by pulse height defect measurements. It was found that the window thickness D strongly depends on the reverse voltage U_A. This dependence may be described by the function $U_A = F(D)^{-\eta}$. The influence of the following parameters on the constants F and η was measured: doping concentration of the base material, energy of the implanted ions, total number of implanted ions, annealing temperature, and crystal orientation. For boron-implanted contacts a formula is given that describes the measured results within 20%. Under certain conditions extremely thick windows up to 10 μm were found. In high resistivity material (100,000 ohm · cm) for example thin windows (<0.02 μm) require high reverse voltage (≈600 V); whereas in silicon with a resistivity smaller than 10000 ohm · cm, thin windows can easily be obtained even at small detector bias. (auth)

26549 EXPERIMENTAL GAMMA RAY RESPONSE CHARACTERISTICS OF LITHIUM-DRIFTED GERMANIUM DETECTORS. **Michaelis, W. (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Instrum. Methods, 70: 253-61(May 1, 1969).**

Experimental determinations of absolute intrinsic efficiency, absolute total absorption probability, and peak-to-total ratio of lithium-drifted germanium diodes for gamma rays between 0.1 and 2 MeV are described for several detector and irradiation geometries. The sensitive volume of the crystals considered ranges from 3.8 to 28 cm^3. The results may be used as a guide in determining the optimum crystal dimensions and irradiation geometry for a given gamma-ray energy. The data are compared with simple models and, if available, with detailed theoretical calculations of the response characteristics. (auth)

26550 A MULTICHANNEL RADIATION MONITOR WITH LOGARITHMIC RESPONSE FROM 0.1 TO 10^6 MREM/hr. **Dzubay, T. G.; Pollock, R. E. (Princeton Univ., N. J.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 586-7(June 1969).**

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

A radiation monitoring system having a very wide dynamic range, relative immunity to radiation damage, and providing continuous audible information feedback to the user was built for the 55-MeV Princeton AVF Cyclotron. A remote sensor in each room consists of a 1 × 2-in. plastic scintillator and photomultiplier. At the control room there is a dc amplifier with output proportional to the log of the anode current, and hence to the dose rate. This is examined by two independently adjustable set points with DTL outputs which establish limits for human occupancy and for radiation damage to equipment respectively. For each channel discrete pulses from the photomultiplier are also amplified and operate a loudspeaker placed near the detector. When the lower set point is tripped the speaker broadcasts a siren-like tone. A failure condition logic signal is generated if discrete pulses are not present when the low level set point is not tripped. Although this type of detector does not directly respond to slow neutrons, it does indicate the radiation hazard by detecting the fast neutrons and capture gamma rays which accompany them in a cyclotron environment. (auth)

26551 EMPIRICAL DETERMINATION OF COUNTER VARIANCE. **McWilliams, P. C. (Gonzaga Univ., Spokane, Wash.); Furchner, J. E.; Drake, G. A. Health Phys., 16: 769-72(June 1969).**

It is stated that significant discrepancy between theory and fact was found during an attempt to apply appropriate statistical techniques to biological retention and excretion data, and a measured empirical variance gave better results than those based on theoretical variance. A non-linear least squares program at Los Alamos Scientific Laboratory to fit the various functions involved is described, and some examples of its application are given. Empirical variance estimates have been incorporated in computer programs. (UK)

26552 EXAMPLE OF RESEARCH ON RADIOPROTECTION IN A UNIVERSITY ENVIRONMENT: IONIZATION CHAMBERS FILLED WITH DIELECTRIC LIQUIDS. **Blanc, Daniel (Univ., Toulouse). Radioprotection, 3: 215-26(1968). (In French).**

The research done at the University of Toulouse on ionization chambers filled with dielectric liquids is briefly summarized. The development of a filling equivalent to biological tissues is discussed. Large volume and small volume ratemeters are described. It is shown how these studies, initially begun for the development of new detectors, have progressively led to basic physical and chemical studies. (J.S.R.)

26553 GAS MULTIPLICATION IN AIR-FILLED IONIZATION CHAMBERS. **Bengtsson, L. G.; Goodman, L. J.; Rossi, H. H. (Columbia Univ., New York). Health Phys., 16: 756-8(June 1969).**

Gas multiplication is employed to facilitate the measurement of small ionization currents. Air has some serious disadvantages as a multiplication gas, but in view of its convenience it has been used for counting alpha pulses. The oxygen readily forms negative ions, giving rise to a wide variety of pulse shapes and sizes, but if only total current is measured individual pulses have little significance. Another disadvantage of air is the production of photons, which release secondary electrons at the cathode, but by use of a cathode of high work function the attainable multiplication can be high. Air multiplication also starts at rather high field strength, but by use of a cylindrical chamber with a thin central wire the applied potential can be kept to a moderate level. Some investigations of air multiplication are described using a 25 cm long chamber, with a 1.9 cm diameter cathode of tissue equivalent plastic and a 0.0064 cm diameter stainless steel wire anode, and a ^{226}Ra source. Chamber parameters for a multiplication of about 300 are summarized, and results are discussed. It was evident that air can be used in a multiplication chamber designed to measure γ-ray dose. Neutron sensitivity may be strongly energy dependent, and caution should be observed in considering use of the chamber with indirectly ionizing radiations that produce ionizing secondaries. The chamber can be used at the dose rates normally encountered in health physics monitoring. (UK)

26554 PHOTOGRAPHIC TECHNIQUE FOR MONITORING ^{222}Rn AND DAUGHTER PRODUCTS. **Bedrosian, P. H. (Public Health Service, Montgomery, Ala.). Health Phys., 16: 800-2 (June 1969).**

A rapid photographic monitoring technique based on a radium leak test procedure which is capable of discriminating between radon and its daughter products is proposed [Bedrosian, Am. J. Roentg, 102: 207(1968)]. The method involves the formation of an image on high speed photographic emulsion by the interaction of alpha particles of airborne radon and associated daughter products with a ZnS phosphor. (auth) (UK)

26555 WHOLE-BODY COUNTER WITH ROTATING DETECTORS. **Anderson, Jesse L.; Parker, Deray; Olson, Dale G.**

(Atomic Energy Commission, Idaho Falls, Idaho). Health Phys., 16: 709-17(June 1969).

A whole-body counter is described that measures radionuclides in humans by the accumulation of one or more gamma ray spectra while rotating detectors scan the body. The scanning path is a helix, and hence the detectors move over the entire surface of the body between the selected limits of the scan. The counter can be used to determine simultaneously the specific gamma emitting nuclides in the body and their distribution by the accumulation of multiple spectra without interruption of the overall scan. For this method of counting, the scan is divided into increments by alternating the modes of operation of two analyzers between accumulative and readout while the detectors move at a constant rate over the surface of the body. Separate spectra are obtained for different sections of the scan to indicate the relative quantities of radionuclides in different parts of the body. These spectra can be summed to obtain a single spectrum for the complete scan, and quantities of specific radionuclides in the total body are determined from this spectrum. Because the detectors rotate completely around the radioactive sources in the body, the integrated counting rate per unit of activity remains nearly constant even when the radionuclides are measured under markedly different conditions of distribution. Distribution of gross gamma activity in the body is determined by recording counting rates as a function of short increments along the helical path of a single detector. The data are shown in the form of isocount or contour plots. Each line represents a different level of activity on a grid that defines positions on the surface of the body. (auth) (UK)

26556 WHOLE-BODY COUNTER FOR ROUTINE MONITORING. Chhabra, A. S. (Bhabha Atomic Research Center, Trombay, India). Health Phys., 16: 719-26(June 1969).

A simplified whole-body counter, designated as "shielded chair," was developed for routine monitoring of occupational subjects of Bhabha Atomic Research Center. It incorporates a mild steel shielded chair weighing about 3 tons, and a NaI(Tl) crystal detector, of 4 in. dia. 3 in. thick, shielded with $1\frac{1}{2}$ in. thick Pb. The crystal assembly, weighing about 550 lbs., is mounted on a plate hinged to the side of the shielded chair frame. Background data are presented. Variations in the response for a point source of ^{137}Cs moving inside the phantom are depicted graphically. Sensitivities for various radionuclides for both integral counting above 50 keV and the photopeak region are given. A system of integral counting with a single adjustment on the upper ceiling in counts per minute was devised which takes care of almost all of the gamma emitting radionuclides in quantities in excess of the cumulative half yearly intake for occupational exposures to maximum permissible concentration in air or water as recommended by ICRP. This would suffice for a quick routine monitoring of occupational workers and it simplifies the electronic circuitry and its associated maintenance problems. The sensitivity of the system is sufficient to detect easily the potassium and ^{137}Cs content of a normal subject. (auth) (UK)

26557 PROPORTIONAL COUNTER FOR PERSONNEL NEUTRON DOSIMETRY. Yoshida, Y.; Dennis, J. A. (Atomic Energy Research Establishment, Harwell, Eng.). Health Phys., 16: 727-34(June 1969).

A proportional counter was developed as a solution to the specific problem of measuring the dose equivalent to personnel from neutrons in the energy range 10–500 keV. The sensitivity in free air of these counters to fast neutrons is 60 ± 12 counts/mrem over the energy range of 20 keV–17 MeV, with an estimated threshold energy for fast neutron detection of less than 10 keV and a sensitivity to thermal neutrons of about 30 counts/mrem. The discrimination against ^{60}Co gamma is better than 2% (i.e., a sensitivity of less than 1.2 counts/mrem of gamma radiation). When the counter is in contact with a human body the sensitivity to thermal neutrons is increased to 50 counts/mrem and the sensitivity to a 1/E spectrum of neutrons up to 10 keV becomes about 20 counts/mrem in comparison to the fast neutron sensitivity of 70 counts/mrem. These values differ from the free air values because of the effects of neutron reflection from the body. It is suggested that it will be possible to modify the counter to measure with reasonable accuracy the dose equivalent from neutrons over the entire range from thermal to 20 MeV. (auth) (UK)

Nuclear Spectroscopic Instrumentation

Refer also to abstract 28243.

26558 (IITRI-578-P-33-6) DEVELOPMENT OF NEUTRON SPECTROMETRY FOR CRITICAL FACILITIES. Quarterly Report No. 2, January 1–March 31, 1969. Semmler, R. A. (IIT Research Inst., Chicago, Ill.). Apr. 1969. Contract AT(11-1)-578. 21p. Dep. CFSTI.

The development of a wall-less proportional counter for neutron spectrometry is described. Work on computer codes for data reduction and work on the detector head itself are discussed. Work on refurbishing the detector was completed and testing was started. Wire failures during the test period, however, have resulted in about 50% downtime for repairs. A revised test schedule is presented as well as the data collected for the following areas: breakdown voltage, ion drift time, calculated and measured resolution, field tube voltage, proportional operation tests, and schemes for combining the wall-less counter technique with pulse shape discrimination. A computer program to convert idealized proton recoil spectra to neutron spectra has been adapted for local use from a code developed at Argonne National Laboratory. (auth)

26559 (KFK–558) A PRECISION PULSER WITH 10 ppM LINEARITY AND STABILITY. Horsch, F. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Kernphysik). July 1968. 18p. (In German). Dep.

In order to use completely the resolution capacities offered by semiconductor detectors, it is necessary to digitally stabilize the amplifier and ADC and to correct the channel-energy relation carefully for nonlinearities of the spectrometer system. For this purpose a precision pulser was developed. It has a linearity of ±10 ppM and a stability of ≤10 ppM/°C. The most important components of the device are a Zener diode reference (in which the diode is accommodated in a temperature-stabilized oven and is compensated against power supply voltage oscillations), a Kelvin Varley precision potentiometer, and a chopper-stabilized operational amplifier as impedance converter. Special care was used in layout of the circuit so that imperfections of the components, contact resistances, and contact thermoelectric voltages can have no significant effect on the stability of the pulser signal. In a four-week test the direct voltage before the mercury relay remained stable to ±5 ppM. A comparison of the divided direct voltages before the mercury relay from two pulser exemplars gave a relative non-linearity of <±5 ppM. Three methods for the correction of a pulse height spectrum to the non-linearity of the spectrometer system with the help of the precision pulser were described. Additional applications were given. (tr-auth)

26560 (N–69-15750) A FAST NEUTRON SPECTROMETER OF ADVANCED DESIGN. Final Report, May 1, 1966–June 30, 1967. Zagotta, W. E.; Moler, R. B. (IIT Research Inst., Chicago, Ill.). June 30, 1967. Contract NAS8-11885. 68p. (NASA-CR–98236; IITRI-V–6020-28). CFSTI.

This report describes the development and initial testing of a ^{3}He sandwich-type neutron spectrometer. A unique feature is that the ^{3}He gas is used as the filling gas of two identical proportional counters which permits effective discrimination against background gamma radiation, discrimination against interfering reactions in the silicon detectors, and an improvement in resolution, especially at low neutron energies. The preprototype system exhibited a 5.48-MeV alpha resolution of from 150 to 250 ceV, FWHM, and a thermal peak resolution of 200 keV. It was found that, in the absence of a neutron source, no accidental gamma events could be observed up to gamma dose rates of 10^{5} r/hr. A modification of the system to one using thinner solid-state detectors and a neutron converter material of ^{6}Li is suggested. It is expected that the modified system will perform in gamma backgrounds as high as 10^{4} r/hr with a resolution of about 0.5 MeV. (auth) (STAR)

26561 COMBINATION NEUTRON AND GAMMA-RAY SPECTROMETER. Meyer, W.; Simons, G. G.; Donnert, H. J. (Kansas State Univ., Manhattan). Nucl. Instrum. Methods, 70: 221-4 (Apr. 15, 1969).

Comments on the fast neutron-spectrometry work of Cialella and Devanney (Nucl. Instr. and Meth., 60: 269(1968)) are provided. Of particular interest is the PuBe new spectrum structure described by these authors, below 4 MeV; very likely this structure does not exist, but is rather the result of oscillations introduced by the raw-data unfolding procedure. (auth)

26562 COMMENTS ON COMMENTS ON A COMBINATION NEUTRON AND GAMMA RAY SPECTROMETER. Cialella, C. M. (Ballistic Research Labs., Aberdeen Proving Ground, Md.). Nucl. Instrum. Methods, 70: 225-6(Apr. 15, 1969).

Comments on a paper by W. Meyer et al., (Nucl. Instr. and Meth. 70: 221(1969)) which presented comments on a previous paper by the author are presented. The comments are on measuring neutron and gamma spectra simultaneously in a mixed radiation environment with a single detector. (B.G.D.)

26563 DECOMPOSITION OF EMPIRICAL FUNCTIONS AS APPLIED TO RECOIL-PROTON SPECTROMETER DATA. Nisle, R. G. (Idaho Nuclear Corp., Idaho Falls). Nucl. Instrum. Methods, 70: 169-72(Apr. 15, 1969).

The transform approach has been used successfully in the reduction of recoil-proton proportional counter data to obtain neutron spectra. Given an 1/E neutron source, the transform of the transfer function is readily obtained by the use of polynomial transform theory (a digital approximation to the Laplace transform). The spectrum of an unknown source is then derivable directly from the resulting P-transform by polynomial division. The advantages of the method are (a) simplicity, and (b) direct calibration of the instrument for scatter cross section and energy loss per ion pair. (auth)

26564 THEORETICAL AND EXPERIMENTAL INVESTIGATIONS FOR AN IMPROVED APPLICATION OF THE ^{6}Li-SEMICONDUCTOR SANDWICH SPECTROMETER. **Bluhm, H.; Stegemann, D. (Kernforschungzentrum Karlsruhe, Ger.). Nucl. Instrum. Methods, 70: 141-50(Apr. 15, 1969).**

Theoretical and experimental investigations were carried out to improve the applicability of the ^{6}Li-semiconductor sandwich spectrometer for neutron spectroscopy in fast zero power reactors and for the measurement of spectra from stationary radioactive neutron sources. The theoretical treatment presented is capable of calculating the efficiency of any geometry of the spectrometer as a function of the neutron energy in an isotropic flux as well as for beam geometry. The analytical model includes the incorporation of a discriminator threshold and its effect on the overall spectrometer efficiency. Calculated and measured geometrical efficiencies and energy resolutions were compared and showed good agreement. The application of the spectrometer to the determination of source neutron spectra as well as to neutron spectroscopy in the fast zero power facility SNEAK is reported. (auth)

26565 PRAKTYCZNA SPEKTROMETRIA PROMIENIOWANIA GAMMA W BADANIACH TECHNICZNYCH. (Practical Applications of Gamma Spectrometry in Technological Research). Lisieski, Waldemar. Nowatechnika Zeszyt 70. Warszawa, Wydawnictwa Naukowo-Techniczne, 1967. 155p.

Aspects of γ radiation spectrometry in physics are reviewed in the first chapter. Single-channel and multichannel spectrometry are discussed in the second and third chapter. Spectrogram scanning techniques and practical applications of γ spectrometry in geology, radiochemistry, medicine, industry, and radioprotection are covered in the fourth and fifth chapters. (R.V.J.)

26566 RANDOM BEAM PULSING AS A MEANS OF IMPROVING THE EFFICIENCY OF SOME TIME-OF-FLIGHT EXPERIMENTS. **Galloway, R. B. (Univ. of Edinburgh). Nucl. Instrum. Methods, 70: 262-8(May 1, 1969).**

An assessment is presented of the possibility of improving the efficiency of some time-of-flight experiments by employing a beam which is pulsed randomly in time and at a higher rate than is usual, in conjunction with a multiple stop time encoder. It is argued that in many cases a 5 to 10 fold improvement in efficiency should be possible. (auth)

26567 RESOLUTION AND SENSITIVITY CONSIDERATIONS OF AN AUGER ELECTRON SPECTROMETER BASED ON DISPLAY LEED OPTICS. **Taylor, N. J. (Varian Associates, Palo Alto, Calif.). Rev. Sci. Instrum., 40: 792-804(June 1969).**

Some of the important considerations in the design of a retarding field analyzer suitable for Auger electron spectroscopy based on display LEED optics are described. From such considerations an instrument has been built with an instrumental linewidth of less than 0.3% (resolution greater than 360). Analysis is made of the limitations insensitivity of the device due to shot noise, and on this basis a comparison is made with a 127° cylindrical electrostatic analyzer. The analysis can be readily extended to other forms of retarding field and deflection analyzers. (auth)

26568 DIRECT COMPENSATION FOR INTENSITY LOSSES DUE TO RANDOM-SUMMING EFFECTS IN SOLID-STATE AND SCINTILLATION SPECTROMETERS. **Henry, L. C.; Kennett, T. J. (McMaster Univ., Hamilton, Can.). Nucl. Instrum. Methods, 70: 337-9(May 1, 1969).**

An experimental method which accounts for uncertainties arising from random-summing effects and truncation limits has been developed. (auth)

26569 A FLEXIBLE COINCIDENCE SYSTEM. **Simms, P. C. (Purdue Univ., Lafayette, Ind.). Nucl. Instrum. Methods, 70: 311-16(May 1, 1969).**

A flexible system is described which will provide coincidence resolving times from 5 nsec to milliseconds. The instrument is contained in a double width NIM module. There are four input channels and two coincidence circuits which can be connected for many coincidence configurations. Several applications are discussed including a method for measuring true and accidental coincidences simultaneously. (auth)

26570 DATA CONTROL, CORRECTION, AND EVALUATION OF GAMMA SPECTRA WITH A LARGE COMPUTER. **Freiburg, C.; Erdtmann, G. (Kernforschungsanlage, Juelich, Ger.). Messtechnik, 77: 8-15(Jan. 1969). (In German).**

Data processing of gamma ray spectra from multichannel analyzers on an IBM-360/75 computer is described. Transfer of data is done via punched paper tape. Prior to the evaluation program a preliminary program is run. The essential purpose of this is the elimination of false data; it consists of the following parts: input of tapes, decoding, checking of formats and control of data. The evaluation program by the method of Least Squares contains the following steps: input of corrections, compensation of gain-shifts, subtraction of background spectra and quantitative determination of the radionuclides composing the unknown sum spectrum. Supernumerary standards being introduced will be eliminated by the program. Another evaluation program determines the position of photopeaks. Up to now it has been used for the recognition and correction of gain-shifts. (auth)

26571 GAMMA SPECTRUM ANALYSIS COMPUTATIONS USING A SMALL COMPUTER. **Keefer, D. H.; Goodwin, H. F.; Ennis, W. J. (Florida State Board of Health, Jacksonville). Health Phys., 16: 792-4(June 1969).**

It is pointed out that gamma spectrum analysis has been perfected to the degree that it is possible to determine nine or more radionuclides simultaneously without changing the composition of the sample. Manual calculation in these circumstances is a time consuming task, and the application of computers to the problem is discussed. The emphasis is on the use of business type computers. Program development and computer implementation are considered. The time required for calculations for 9 nuclides is stated to be <10 sec. per sample. The storage of gamma spectra data on magnetic tape also creates a source of basic radiological data. (UK)

High Energy Physics Instrumentation

Refer also to abstracts 27920, 28120, and 28201.

26572 (KFK-769) THE DEVELOPMENT OF A SYSTEM OF DIGITIZED SPARK CHAMBERS IN COMBINATION WITH A COMPUTER. **Schmidt-Parzefall, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). Sept. 1968. 80p. (In German). Dep.**

Digitized spark chambers with ferrite core memory were developed. The detection and resolution characteristics of the spark chambers were measured and the use of a system of spark chambers and process computers in an e-d scattering experiment at DESY were described. (tr-auth)

26573 SPIRAL READER MECHANICAL DRAWINGS (Engineering Materials). **(California Univ., Berkeley. Lawrence Radiation Lab.). (CAPE-1574).**
685 drawings.

Mechanical drawings for the Spiral Reader are described. The reader is a semiautomatic film digitizing machine used to measure photographs of elementary nuclear-particle interactions which are created in a hydrogen bubble chamber. The machine measures events at the rate of 75/hr. A PDP-4 computer is used on-line as a controller of the machine's servomechanism; as monitor and guide to the measuring procedure; and to convert, check, and display. (For details see TID-4100, Suppl. 53). (F.S.)

26574 NANOSECOND PULSE GENERATOR FOR SPARK CHAMBER. **Alikhanyan, A. I.; Aleksanyan, A. S.; Vorob'ev, G. A.; Kavalov, R. L.; Krol, V. K.; Rudenko, N. S.; Tsvetkov, V. I. (Inst. of Physics, Erevan). Izv. Akad. Nauk Arm. SSR, Ser. Fiz., 3: 303-13(1968). (In Russian).**

A pulse generator giving pulses up to 698 kV with a rise time of 2 nsec t is described. In includes a Marx generator, an accumulation capacitor, a discharge chamber, a transfer line, and a strip line where the spark chambers are installed. The generator is powerful (the discharge capacity is 1000 pF) and the pulse length can be changed with a good accuracy by a spacial two-electrode discharger. The spark chamber was supplied with pulses of 10 to 25 kV/cm electric field strength. At high strength the streamer velocity rises and the requirements to the pulse length and to the stabilization of high voltage pulse becomes critical. (auth)

26575 SCREENING FROM THE ELECTROMAGNETIC FIELD OF SPARK CHAMBER DISCHARGE. **Vardumyan, D. T.; Marikyan, G. H.; Matevosyan, K. A. (Inst. of Physics, Erevan). Izv. Akad. Nauk Arm. SSR, Ser. Fiz., 3: 314-17(1968). (In Russian).**

The question of the screening of spark chambers operating together with an ionization calorimeter placed just under the spark chambers is studied. A screening box allowing one to measure pulses with amplitude ≥ 100 μV from the ionization chambers at a simultaneous operation of the spark chambers with a 100 kV high voltage pulse is constructed. (auth)

26576 HIGH VOLTAGE PULSE GENERATOR FOR WIDE GAP SPARK CHAMBER. Avakyan, K. M.; Voskanyan, F. V.; Melikyan, E. G. (Inst. of Physics, Erevan). Izv. Akad. Nauk Arm. SSR, Ser. Fiz., 3: 362-5(1968). (In Russian).

A 15-stage Arkadiev–Marx generator with a maximal output of 450 kV is described. The delay between the trigger and the output pulses is about 30 nsec and the rise time of the output pulse is smaller than 1.9 nsec. (auth)

26577 A RECIRCULATOR–PURIFIER FOR SPARK CHAMBER NEON GAS. McLaughlin, E. F.; Schafer, R. V. (Univ. of California, Berkeley). Nucl. Instrum. Methods, 70: 343-5(May 1, 1969).

The main components of this closed-system recirculator-purifier are a circulating pump, a pressure-regulating system, and a purification bed. Gas flow rates of up to 35 ft^3/h may be obtained while the spark chamber is held at a preset pressure plus or minus 0.02" of water. In normal routine operation the impurity level of the gas can be held to less than 50 ppM. (auth)

26578 NEW TECHNIQUES FOR LARGE WIRE SPARK CHAMBERS WITH MAGNETOSTRICTIVE READOUT. Grove, R. L.; Perez-Mendez, V.; Van Tuyl, R. (Univ. of California, Berkeley). Nucl. Instrum. Methods, 70: 306-10(May 1, 1969).

Methods are described by which large wire spark chambers can be constructed and read out with uniform efficiency and accuracy over their entire length. The high uniform efficiency for registering multiple tracks is obtained by the use of auxiliary conducting planes which serve to charge the chamber capacity with a low impedance transmission-line characteristic. The magnetostrictive readout is improved by the use of torsional pulses in the sense wire which provide a greater degree of linearity than the longitudinal pulses used previously. (auth)

26579 ADHESIVE AND INSULATING SYSTEMS FOR CRYOGENIC AND SUPERCONDUCTING COILS. Markley, F.; McKamey, A.; Biggs, J. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 734-5 (June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The superconducting coils for the Argonne 12-ft bubble chamber were assembled with an epoxy adhesive and a Teflon insulating interlayer. The design of a cryogenic adhesive system capable of taking the strains induced by temperature differentials or differences in thermal expansion coefficients is discussed. Adhesive and insulating materials capable of appreciable elongation at cryogenic temperatures are required. Commercial materials are compared. Mechanical test data on the adhesive shear strength at ambient and liquid nitrogen temperatures, on the effect of surface treatments for the copper and the Teflon, on the effect of the adhesive and insulation film thicknesses, and on the creep of thin, bonded Teflon films are presented. Assembly procedures for the actual 15-ft. inside diameter coils are illustrated. The epoxy, Teflon film adhesive system can be adapted to any cryogenic or superconducting coil using strip conductor, or to other cryogenic bonding problems such as the cryogenic titanium to glass bond for the photographic windows for the 12-ft Liquid Hydrogen Bubble Chamber. Some data from the window bonding tests are presented to illustrate the effect of the coefficient of thermal expansion of the interlayer material. (auth)

26580 INERT GAS PURIFIER FOR SLAC'S TWO-METER STREAMER CHAMBER. Thingstad, Per (Stanford Linear Accelerator Center, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 659-60(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

This purifier was built to purify the 90% Ne-10% He gas mixture in SLAC's two-meter streamer chamber. The streamer chamber had two gas cells race-track shaped, each with overall dimensions of 95 × 65 × 12 inches. The cells were made of polyurethane foam; 12 m^2 of 2-mil mylar separated the gas from the atmosphere. A $\frac{1}{2}$-in. dia, 95-in. long mylar tube with a 4-mil wall ran through one of the cells and contained hydrogen gas at 80 psig. Initially, a chemical system was built to purify the gas. Later a cryogenic system was built and successfully tested in last summer's experiment. Because of the large mylar surfaces the pressure regulation of the chambers is very critical. The system is described as well as its capacity to absorb contaminants. Some cost figures and data from last summer's experiment are included. Both the calculated and the measured contamination rate increase in the cells are described. A mass spectrometer was hooked up to the system, and the purity of the gas in the chamber was measured as it was purified. The apparent purity requirement for good streamers is described. (auth)

Radiation Dosimeters

Refer also to abstract 26557.

26581 (AERE-R-5876) AUTOMATIC COUNTER FOR PROTON TRACKS IN NUCLEAR EMULSIONS. Moss, G. H.; Rae, J. B. (Atomic Energy Research Establishment, Harwell (England)). Dec. 1968. 19p. Dep. CFSTI. UK 3s. 6d.

An automatic machine was constructed to count proton-recoil tracks in nuclear emulsions used as personal dosimeters for fast neutrons. The machine uses an optomechanical fast scanning arrangement to examine 0.8 cu. mm. of emulsion in 12 minutes. A maximum number of 60 track plates can be automatically examined in 12.5 hours. To discriminate between proton tracks and aggregates of grains in the emulsion, it is necessary to ignore track lengths less than 5 μm, corresponding to 0.5 MeV protons. The energy response shows reasonable agreement with that expected by calculation, and calibration of the dosemeter/reader combination by Pu–Be neutrons gave a linear relationship up to 4.5 rem. with a background of 0.1 rem. (auth) (UK)

26582 (AERE-R-5929) OPTICAL DENSITY MEASUREMENT BY A NULL-METHOD FOR AN AUTOMATIC DENSITOMETER. Rae, J. B. (Atomic Energy Research Establishment, Harwell (England)). Dec. 1968. 13p. Dep. CFSTI. UK 2s. 6d.

A split beam optical densitometer is described for use in an automatic machine to assess photographic film radiation exposure. A close approximation to British Standard Diffuse Density is measured over the range 0 to 3 with an accuracy of 0.005 density units. (auth) (UK)

26583 (AERE-R-6008) U.K. MEASUREMENTS AT THE FIFTH INTERNATIONAL INTERCOMPARISON OF NUCLEAR ACCIDENT DOSIMETRY SYSTEMS, O.R.N.L., JULY 1968. Adams, N.; Dennis, J. A. (Atomic Energy Research Establishment, Harwell (England)). Jan. 1969. 35p. Dep. CFSTI. UK 5s. 0d.

In a series of exposures to mixed neutron and gamma fields produced by the Health Physics Research Reactor at ORNL, teams from several countries compared their systems for assessing doses in criticality accidents. The measurements made by the Harwell team, both in free-air and on phantoms, with A.E.R.E. criticality dosimeters and a threshold detector system are given. These measurements are compared with those made by the other teams. Doses assessed from A.E.R.E. criticality dosimeters, using a modification of the original method of interpretation described by J. A. Dennis in AERE-R 4365 (1964), were in good agreement with those from more complex dosimeters. This modified method of interpretation may also be applied to measurements of body sodium activation and the sulfur threshold reaction, to give reasonable dose estimates; this technique could be applied in cases of irradiation in which dosimeters were not worn. The sodium activation in 18 cm diameter cylindrical phantoms was found to be very nearly the same as in man-like phantoms. The use of such phantoms in installed dosimetry systems is recommended. Conceptual inadequacies of the assessment of intermediate-energy neutron doses from threshold detector systems are briefly discussed, and more work on this problem is recommended. (auth) (UK)

26584 (AERE-R-6037) AUTOMATIC CALIBRATION OF RADIATION MONITORING FILMS. Holt, P. D. (Atomic Energy Research Establishment, Harwell (England)). Mar. 1969. 15p. Dep. CFSTI. UK 2s. 6d.

A jig is described for exposing calibration films (or thermoluminescent dosimeters) to known doses of gamma radiation. Films are exposed in two perpendicular planes to enable the maximum number to be exposed at one time. The source is cylindrical and is exposed horizontally by a pneumatic method which enables automatic timing to be incorporated. The source exposure system works well, and the uniformity of dose at any one distance from the source is sufficient provided not more than four films at the same dose level are required from one exposure. The jig is in routine use at Harwell. (auth)

26585 (CLOR-69-D) A SIMPLE MOSFET CHARGE-TO-PULSE CONVERTER FOR THERMOLUMINESCENCE READER. Glowacki, St. (Centralne Laboratorium Ochrony Radiologicznej, Warsaw (Poland)). 1968. 7p. Dep.

A simple charge-to-pulse converter circuit is described. The converter is simple, reliable and transforms proportionally charge-to-pulses for the current in the range from 5×10^{-10} to 5×10^{-4} A. The circuit has been designed especially for the application in a thermoluminescence reader. (auth)

26586 (RD/B/N-1332) CALIBRATION OF THE MARK I PERSONAL NEUTRON ALBEDO DOSIMETER AT TRAWSFYNYDD NUCLEAR POWER STATION. Hall, J. A.; Hudd, W. H. R. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Mar. 1969. 10p. Dep. CFSTI. UK.

The response of the Mark I albedo dosimeter was investigated in working areas of the Trawsfynydd Nuclear Power Station. Calibration factors to convert dosimeter reading to total neutron dose equivalent were evaluated. The orientation of the dosimeter and phantom was shown to affect the dosimeter reading and this was taken into account. (UK)

26587 USE OF QUASI-ADIABATIC CALORIMETERS FOR IN-PILE DOSIMETRY. Aleksenko, Yu. I.; Mukhina, G. V.; Pokhlova, L. P.; Khramchenkov, V. A. At. Energ. (USSR), 26: 328-31(Apr. 1969). (In Russian).

Some aspects of quasi-adiabatic calorimeters for in-pile dosimetry are discussed. A theory for evaluation of the proper calorimeter dimensions and the error due to thermocouple material are given. The possibility of the differential determination of fast neutron and gamma dose is discussed. The results are illustrated with the experimental data obtained in RFT-reactor. (auth)

26588 ^{7}Li DOSIMETER GLASS FOR SIMULTANEOUS MEASUREMENT OF THERMAL NEUTRON AND COEXISTING γ-RAY DOSE. Yokota, Ryosuke (Tokyo Shibaura Electric Co., Ltd., Kawasaki, Japan); Nakajima, Saburo; Bingo, Kazuyoshi. J. Nucl. Sci. Technol. (Tokyo), 6: 224-6(Apr. 1969).

A new glass was developed which has been designated as FD-3(^{7}Li), since all the natural lithium in FD-3 glass is replaced by ^{7}Li of 99.9% purity and has about the same amount of predose as FD-3. (B.G.D.)

26589 DISPERSE SCINTILLATORS FOR γ-RADIATION DOSIMETERS. Vershinina, S. P.; Volosyuk, G. P.; Tsirlin, Yu. A.; Strzhemechnyi, M. A. At. Energ. (USSR), 26: 341-4 (Apr. 1969). (In Russian).

Dosimetric disperse scintillation detectors made of a mixture of organic and inorganic compounds are discussed. The elaborate method permits calculation of energy response of the detectors described. (auth)

26590 SCINTILLATION COUNTER FOR IMPROVING MEASUREMENT OF RADIATION DOSE. Moriuchi, Shigeru (to Japan Atomic Energy Research Inst.). U. S. Patent 3,441,733. Apr. 29, 1969. Priority date Nov. 1, 1963, Japan.

A radiation dose measuring device having means for flattening the energy response of a scintillation counter by applying an ac bias to the crest discriminator is described. The ac bias is determined by the type of radiation detector and the type of the radiation dose to be measured. (Offic. Gaz.)

26591 METHOD OF DETERMINING RADIATION DOSE THROUGH A PACKAGE AND DOSIMETER THEREFOR. Attix, Frank H. U. S. Patent 3,440,420. Apr. 22, 1969. Filed Apr. 30, 1965.

The subject matter of the present invention is directed to a radiation detection system and method for accurately determining radiation dose received by a substance subjected to a radiation source such as an electron beam from an accelerator. The items to be irradiated are placed on a conveyor belt or such similar device on which the items pass through the radiation source. Subsequent to being irradiated, the items are checked to determine the proper amount of radiation dose. Strips of material affected by a radiation source are applied to each, the upper and lower surfaces of each item, thus each dosimeter is examined on the item by an optical system in which the amount of light from a light source passing through the radiation dose material is reflected back to a detector. The reading of the detector indicates whether the item was subjected to sufficient radiation or whether too little or too much radiation was incident on the item. Each item is checked across the width and length of the upper and lower sides to ensure that the items have been irradiated entirely across the width and length thereof. (Offic. Gaz.)

26592 ON APPLICABILITY OF TL FADING TO ESTIMATION OF TIME AFTER IRRADIATION. Nakajima, T.; Hashizume, T. (National Inst. of Radiological Sciences, Anagawa, Japan). Health Phys., 16: 782-3(June 1969).

It is stated that personnel monitoring devices would be more useful if in addition to estimating dose equivalent they could estimate the period since irradiation. Film badges and phosphate glasses present difficulties in estimating this time. Fading is known to occur with thermoluminescence dosimeters, but phosphors which show a large degree of fading have been little investigated. Thermoluminescence fading is thought to be caused by radiative and non-radiative transitions of carriers, and fading of carriers from deep trapping centers may be smaller than from shallow centers. If one of several centers has faded and another has scarcely faded, the ratio H_1/H_2 (thermoluminescence intensity or peak height due to the respective trapped carriers) will be a function of the time after irradiation exposure, and if this ratio can be obtained the time since exposure can be estimated. A study is described of the use of single crystal CaF_2 in this connection, and also of a two-phosphor system comprising $CaSO_4$(Mn) and $CaSO_4$(Dy). (UK)

26593 ULTRASONIC EXCITATION OF THERMOLUMINESCENT LITHIUM FLUORIDE. Kastner, J.; Selner, R. H.; Paden, C. M.; Oltman, B. G. (Argonne National Lab., Ill.). Health Phys., 16: 803-4(June 1969).

Some disadvantages of thermal stimulation of luminescence in radiation dosimetry are mentioned, and an alternative technique was sought. For very low dose rates, as that of the natural environment, black-body emission from the heated dosimeter and its surroundings results in a very poor signal-to-noise ratio. Also, in the investigation of thermoluminescence of organic materials there is the problem of charring and dehydration during the application of heat. It was thought that the application of ultrasonic energy might serve to agitate the crystal lattice and supply enough phonons at electron trap sites to allow the stored energy to be released as luminescence, and some studies were made with irradiated single crystals of LiF employing piezoelectric transducers. It was concluded that the light observed under ultrasonic stimulation was really the result of secondary heating and not a primary acoustiluminescence in the sense of phonon or sound quanta absorption. There appears, thus, to be no intrinsic technical advantage in employing standard ultrasonic techniques to luminescent dosimetry, although in situations where it may be impractical to use a direct heater, indirect heating by conventional ultrasonics may be an advantage. (UK)

26594 USE OF LIGHT SOURCE FOR TESTING THERMOLUMINESCENT DOSIMETER READERS. McCall, R. C. (Stanford Linear Accelerator Centre, Calif.). Health Phys., 16: 811(June 1969).

It is common practice to check the performance of a TLD reader by a light source comprised of a phosphor containing radioactive material, such as ^{14}C. Where measurements of a wide range of dose levels are involved several light sources of different intensities are desirable. This requirement has been met by the commercial provision of sets of two light sources differing by about a factor of 100 in intensity. Some pitfalls in the use of such light sources are discussed. (UK)

26595 AUTO-RANGING READER FOR THERMOLUMINESCENT DOSEMETERS. Casbolt, P. N.; Cliff, K. D. (Radiological Protection Service, Sutton, Eng.). J. Phys., E (London), 2: 511-14(June 1969).

A thermoluminescent dosemeter reader is described which incorporates autoranging facilities, automatic tray vibration, and fixed period nitrogen-flushing. The print-out is automatic and thus the reader is suitable for use by semi-skilled personnel. (auth) (UK)

26596 STRONTIUM FLUORIDE AS A THERMOLUMINESCENT DOSIMETER. Jones, J. L.; Martin, J. A. (Moleculon Research Corp., Cambridge, Mass.). Health Phys., 16: 790-2(June 1969).

As part of a program of developing new dosimetric materials, the post-irradiation thermoluminescence properties of a number of crystalline substances were investigated. The approach followed involved the screening of a large number of readily available compounds with suitable physical properties (high melting point, low solubility) using ^{60}Co radiation. Samples were then heated in a TLD readout machine under a nitrogen atmosphere and glow curves were taken of those that showed thermoluminescence. Those which showed some TLD potential are listed. The only material to pass for further sensitivity and stability requirements was an optical grade of SrF_2. (auth) (UK)

26597 EFFECT OF ATMOSPHERIC TRITIUM ON PHOTOGRAPHIC, THERMOLUMINESCENT, AND RADIOPHOTOLUMINESCENT DOSIMETERS. Denham, D. H.; Kathren, R. L. (Battelle-Northwest, Richland, Wash.). Health Phys., 16: 773-8(June 1969).

A study to ascertain the response of ordinary personnel monitoring film and to verify if film is a useful method for quantifying MPG levels of atmospheric tritium is described. As a corollary, simple methods of mitigating the effects of atmospheric tritium on film were investigated, which would also eliminate another possible source of film badge error. The effects of atmospheric tritium on TLD and RPL glass were also examined; no response was found. (auth) (UK)

26598 ACCIDENT DOSIMETRY BY THERMOLUMINESCENCE OF FELDSPAR SEPARATED FROM SANDS. Ichikawa, Yoneta; Tanida, Michiyo (Nara Univ., Japan). Bull. Inst. Chem. Res., Kyoto Univ., 47: No. 1, 23-6(Jan. 1969).

A preliminary experiment on accident dosimetry by thermoluminescence of natural substances which can easily be found everywhere is presented. The materials used as phosphors were quartz and feldspar, and they were separated from sands or soil by means of a magnetic method and a method of selectively staining. It has been found by this experiment that the most desirable is the 140°C glow peak of feldspar because of its thermoluminescence properties, such as sensitivity, linearity and decay. (auth)

Radiometric Instruments

Refer also to abstract 26623.

26599 STATISTICAL SAMPLING OF A MOVING PRODUCT USING A GAUGING DEVICE WITH A VARIABLE SENSING AREA FUNCTIONALLY RELATED TO A VARIABLE PRODUCT SPEED. **Lowman, Walker B.; Felty, Richard D. (to Industrial Nucleonics Corp.). U. S. Patent 3,440,421. Apr. 22, 1969. Filed Feb. 15, 1965.**

Disclosed herein is a device for statistical quality control analysis of an elongated product such as a cigarette rod. The product is transported past a beta or gamma radiation gauge having an adjustable-length gauging aperture, and coacting controls are provided for the aperture length and the product transport speed so that the ratio of the speed to the aperture length is constant for a given frequency bandwidth of the gauge. A radiation absorbing wedge may be coupled to the aperture length control so that, for a constant product, the radiation received by the detector also remains constant as the aperture length is varied. (Offic. Gaz.)

Miscellaneous Instruments and Components

Refer also to abstracts 26159, 26307, 26441, 26500, 27203, 27353, 27899, 28376, 28504, 28549, 28639, 28654, and 28662.

26600 (AERE-R-5862) MAGNETIC TAPE TRANSPORT FOR DIGITAL DATA LOGGING. Lewis, A. (Atomic Energy Research Establishment, Harwell (England)). Aug. 1968. 22p. Dep. CFSTI. UK 3s. 6d.

A tape transport has been designed for digital data logging operations in which the tape speed is continuously variable from 0.5 to 250 inches per second. The speed may be controlled by the input data rate to maintain approximately constant word density on the tape. A maximum skew of 150 microinches across 1" tape is maintained with all speeds, in either direction of tape travel and over different transports. Seventeen transports have been made to the design and after 10,000 hours the performance specification is maintained. (auth) (UK)

26601 (AERE-R-5962) CASSANDRA: A MEGACHANNEL TIME-OF-FLIGHT ANALYSER. Hall, J. W. (Atomic Energy Research Establishment, Harwell (England)). Nov. 1968. 13p. Dep. CFSTI. UK 3s. 0d.

CASSANDRA is a data collection system for neutron time-of-flight experiments. It can process up to 300 events per second, updating any of half a million counting channels within 8 seconds. The CASSANDRA system is based on the PDP-8; it uses DEC-tape and magnetic drum backing store and has a closed circuit T.V. system looking at a DEC Type 34D display to give remote displays of data. A special interface unit is used to provide feedback from these displays. The CASSANDRA programs control the collection and sorting of data and provide a sophisticated command system that allows unskilled operators to make full use of the equipment. (auth) (UK)

26602 (AERE-R-5997) MECHANICAL X-RAY SAFETY SHUTTERS FOR USE ON PHILLIPS PW 1008 AND 1016 TUBE-SHIELDS. Sampson, C. F.; Bremner, W. B. (Atomic Energy Research Establishment, Harwell (England)). Jan. 1969. 13p. Dep. CFSTI. UK 3s. 0d.

It is pointed out that crystallographic instruments used with proprietary x-ray generators which do not have safety coupling attachments present many difficulties in laboratory supervision. With this in mind safety shutters were designed for the above tubeshields; these shutters are described and illustrated and their principle of operation given. (UK)

26603 (AERE-R-6035) A TIME-OF-FLIGHT SPECTROMETER FOR COLD NEUTRON STUDIES ON THE DIDO 6H HOLE. Stirling, G. C. (Atomic Energy Research Establishment, Harwell (England)). Jan. 1969. 19p. Dep. CFSTI. UK 3s. 6d.

Details are given of the design and performance of a spectrometer planned for use with a pulsed beam of monochromatic neutrons of wavelengths 4 to 6Å, scattered into banks of counters at five or six different angles. Application was intended for the DIDO reactor 6 inch diameter horizontal radial hole, as an interior measure pending the construction of a permanent new design instrument. The spectrometer has been used in connection with the neutron scattering programme, and has been in continuous operation since June 1968. (UK)

26604 (AWRE-O-79/68) COMPARISON OF THE SHORT PERIOD SEISMIC NOISE AT THE FOUR UKAEA TYPE ARRAYS AND AN ESTIMATE OF THEIR DETECTION CAPABILITIES. Burch, R. F. (Atomic Weapons Research Establishment, Aldermaston (England)). Jan. 1969. 18p. Dep. CFSTI. UK 3s.

Samples of short period noise from arrays at Eskdalemuir (Scotland), Yellowknife (Canada), Gauribidanur (India) and Warramunga (Australia) were analyzed by analog methods for both frequency content and amplitude. This analysis was carried out for outputs of both a single seismometer and for the sum of the outputs for all the seismometers in the array. The power of the arrays to increase the signal-to-noise ratio was calculated, and detection thresholds were estimated for the four arrays based on the array processing techniques of "delay and sum." (auth)

26605 (EUR-4101, pp 153-92) INSTRUMENTATION FOR RAPID MECHANICAL TRANSIENTS IN MODEL SCALE EXPERIMENTS. Dato, P. Actis; Holtbecker, H.; Jorzik, E.; Lachapelle, Y.; Maserati, A.; Verzeletti, G. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center).

The instruments used to measure pressures and strains in model studies of structural response to dynamic loading are reviewed. Characteristics of two types of pressure transducers used for high-precision tests, the piezoelectric transducer and the strain-gauge bar transducer, are described in detail. The behavior of strain-gauges in dynamic strain measurements are discussed. Calibration data on the transducers and a description of the shock tube used for the calibration are presented. (H.D.R.)

26606 (JUL-549-ZE) ON THE SUITABILITY OF ARRANGEMENTS WITH NEGATIVE DIFFERENTIAL CHARACTERISTIC RESISTANCE AS FAST ELECTRONIC SWITCHES IN NANOSECOND RANGE. Brocke, Wennemar A. (Kernforschungsanlage, Juelich (West Germany). Zentrallabor fuer Elektronik). Aug. 1968. 141p. (In German). Dep.

Studies were made on fast electronic switches which can be used in the development of double pulse generators for the polarographic high level Faradaic rectification method. A survey was first made of the arrangements and constituents which can be used for electronic switches. The study was limited to those arrangements and constituents with some practical applicability. Qualitative descriptions of the decisive physical mechanisms of the switching processes gave an insight into the functioning of the electronic switches so that they could be systematized according to their switching characteristics and arranged according to their switching times. It was shown that with consideration of the criterion "commercial manufacture" only the rare gas thyratron and the avalanche transistor were suitable as principal switches in combination with the discharge cable. The thyristor can not be used in fast switching without sample measurements since the manufacturer usually gives no high frequency properties or switching speed data. The tunnel diode, because of its low bias-reducing voltage, can be used only as an auxiliary switch for triggering purposes. The characteristic parameters of the switching behavior of these four switches are extensively studied. Two switching designs for single pulse generators with avalanche transistors and rare gas thyratrons are described and discussed. (tr-auth)

26607 (LA-4119-TR) LOW-LEVEL LINEAR GATE AND DISCRIMINATOR. Meynadier, C.; Kamert, J. C. Translated for Los Alamos Scientific Lab., N. Mex., from Nucl. Instrum. Methods, 65: 183-8(1968). 8p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 752. (W.H.K.)

26608 (N-69-10423) DEVELOPMENT OF LITHIUM DIFFUSED RADIATION RESISTANT SOLAR CELLS. Payne, P. (Heliotek, Sylmar, Calif.). Oct. 15, 1968. Contracts NAS7-100; JPL-952247. 16p. (NASA-CR-97470). CFSTI. For Jet Propulsion Lab., Pasadena, Calif.

Various aspects of the lithium cell fabrication process have been investigated. These include application of the lithium by evaporation rather than by the paint-on technique; comparison of the use of an SiO layer to the use of the blue layer obtained in boron diffusion for antireflection layers; and preliminary investigation of sintering lithium cells. The third and fourth lots of lithium cells have been fabricated and delivered to JPL. Yield analyses of these cells have been made and comparison was also made to the first two lots. (auth) (STAR)

26609 (N–69–19034) CONCEPTUAL DESIGN OF A SMALL SOLAR PROBE (SUNBLAZER). Baker, Richard H.; Galvin, Daniel H. Jr. (eds.) (Massachusetts Inst. of Tech., Cambridge. Center for Space Research). Jan. 1969. Contract NASr-249. 524p. (NASA-CR-100034; MIT-CSR-TR-69-1). CFSTI.

A scientific experiment to measure the electron density of the solar corona using apparatus consisting of a small, solar-pressure-oriented spacecraft containing a multiple-frequency, pulsed, 2-kilowatt, solid-state transmitter, and a terrestrial 50-dB dipole phased array receiving antenna is described. Included are analyses of the communication system, the 0.63-AU perihelion solar orbit, the semi-passive attitude control system, the spacecraft power and thermal control systems. The conceptual electrical and mechanical design of the spacecraft hardware covers the basic configuration, rf and digital electronics design and packaging; and includes fundamental stabilization, separation, despin, and deployment schemes. (auth) (STAR)

26610 (RT/EL–(69)1) **CRITERIA FOR THE EMPLOYMENT OF INTEGRATED CIRCUITS IN A CONTROL SYSTEM FOR NUCLEAR EXPERIMENTS. Bevilacqua, S.; Fillarini, G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1969. 34p. (In Italian). Dep.**

Some solutions for electronic digital systems employing integrated circuits are analyzed with respect to price, reliability, and availability. An application to a control system for nuclear experiments is described in detail. (auth)

26611 ELECTRONIC IMPROVEMENTS OF THE PARTICLE RESOLVING POWER IN SPACE-CHARGE DISCRIMINATION. Jentsch, W.; Wiesner, K. (Institut fuer Experimentelle Kernphysik, Dresden). Kernenergie, 12: 25-7(Jan. 1969). (In German).

The possibility of using space charge saturation in photomultipliers for particle discrimination is restricted by the existence of an upper limit of energy at which a distinction of the particles recorded becomes impossible. In the case of neutron-gamma discrimination, this value is 3 to 4 MeV neutron energy with optimum lower limit of resolution. Electronic circuits are proposed which allow particle discrimination up to 14 MeV neutron energy. (auth)

26612 IONIC PUMPS VIA SYNCHRONIZED ELECTRIC AND MAGNETIC FIELDS. Chen, Hsing-yao. Storrs, Conn., Univ. of Connecticut, 1968. 103p.
Thesis.

The possibility of applying a synchronized crossed field pumping mechanism to ionized gas or plasma is studied. A differential equation of ion motion in a synchronized crossed field has been derived and solved, and a set of acceleration, velocity and position equations are obtained as the solution of the differential equation. These solutions reveal that under the synchronized crossed field condition a controlled ion motion can be obtained with a net acceleration in the direction of migration. Also, the condition for both controlled electron and ion motion is discussed. The pumping mechanism is suggested to be used in vacuum pumping and ionic propulsion. A detailed discussion about the application in both cases is given, and also, some feasible future developments are cited. Experiments have been done which indicate that the synchronized crossed field pumping effect does exist in the ionized gasses. (Disser. Abstr.)

26613 PORTABLE NEUTRON GENERATOR (Engineering Materials). (General Electric Co., St. Petersburg, Fla. Neutron Devices Dept.). (CAPE–1866).
214 drawings.

A neutron generator used to evaluate equipment is described. The portable generator weighs 43 lbs and is housed in a fiberglass suitcase 7 in. by 12 in. by 21.5 in. A 26 A Controltron tube (sealed gas-filled neutron source tube) is employed. The output of the generator is stabilized after about a 30 min warm-up at ambient temperature of ~20°C. The output level is resettable to within 2.3 to 5.4%. (For details see TID-4100, Suppl. 53)(see also 23: 2692.) (F.S.)

26614 ELECTRICAL CONTROL SYSTEMS. Pringle, Anthony (to English Electric Co. Ltd.). British Patent 1,150,644. Apr. 30, 1969. Filed Dec. 21, 1965.

Reference is made to control systems connected between a number of groups of first electrical devices and a number of groups of second electrical devices, whereby each first device can be connected in a continuous repeated sequence with each second device. The arrangement is such that in each group of first devices no two devices are associated with the same second devices. Such systems are especially useful where the second devices are controlled by the first, but must not operate except under certain conditions, for instance in a temperature protection system for a nuclear reactor, where shut-down amplifiers are required to operate only in response to abnormal signals from more than one thermocouple in a particular zone of the reactor. Full details of the system, including circuit diagrams, are given. (UK)

26615 GENERAL PURPOSE PULSE SHAPE DISCRIMINATING CIRCUIT. **Kinbara, S.; Kumahara, T. (Japan Atomic Energy Research Inst., Tokai, Japan). Nucl. Instrum. Methods, 70: 173-82(Apr. 15, 1969).**

A new general purpose pulse shape discriminating circuit and its applications are described. The circuit is based on a risetime to pulse height converter which can measure, independently of its input pulse height, an arbitrary fraction of the risetime of the input pulses. The feature of this circuit is that this can define the risetime of the input signals in the range of 0.2 to 10 μsec with an accuracy of ±2% for a pulse height range of 0.3 to 10 V. In applications, this circuit can perform n-γ discrimination with a liquid scintillator, a usual photomultiplier and a linear amplifier, and the gamma rejection ratio obtained for neutrons less than 500 keV is better than 1/500. Also a gamma rejection ratio nearly 1/50 can be obtained for neutrons less than 60 keV by using an H-filled proportional counter. When neutron capture gamma rays are measured with a 20 cm^3 coaxial type Ge(Li) detector in a reactor, the background reduction by 50% and the improvement of a photopeak width by 20% are obtained by using this circuit. Furthermore, when it is applied to (n-γ)T reaction measurement with a Si(SB) detector in the reactor, an improvement of the tritium peak width by 50% and a background reduction by a factor of ten are obtained. It is also investigated that pileup rejection and characteristics measurement of semiconductor detectors can be easily performed by using this circuit. (auth)

26616 FAST dc COUPLED ANALOGUE FAN-IN AND FAN-OUT MODULES. **Herbst, L. J. (Rutherford High Energy Lab., Chilton, Eng.). Nucl. Instrum. Methods, 70: 185-8(Apr. 15, 1969).**

Dc coupled fan-in and fan-out modules are described suitable for working with nanosecond analog signals. The modules have a rise time of about 3 ns. The quiescent dc input levels have temperature coefficients of about 30 μV/°C. The corresponding temperature coefficients for the quiescent dc outputs are 20 μV/°C for the fan-in, and 90 μV/°C for the fan-out unit. The differential linearity of both modules is about ±1% and the voltage gain stability is 0.04%/°C. (auth)

26617 **FAST AMPLITUDE DISCRIMINATORS FOR NUCLEAR INSTRUMENTATION. Herbst, L. J. (Rutherford High Energy Lab., Chilton, Eng.). Nucl. Instrum. Methods, 70: 189-99 (Apr. 15, 1969).**

Three amplitude discriminators designed for working with nanosecond pulses at rates up to 10 megapulses/sec are described. One of the units is a general purpose discriminator with a constant dead time of 80 ns and a time walk of about 1.5 ns. The second discriminator is based on this module and contains additional logic giving constant dead times from 100 ns to 20 μs. The third discriminator operates on the zero crossing principle and is intended for applications where timing accuracy is most important. (auth)

26618 DIGITAL COMPUTER APPLICATIONS FOR DATA PROCESSING OF NUCLEAR REACTORS AND POWER PLANTS. I. GENERALITIES ABOUT DIGITAL COMPUTER DATA PROCESSING. Chapelot, A.; Moinereau, P. Energ. Nucl. (Paris), 10: 490-501(Dec. 1968). (In French).

The problems posed by the processing and evaluation of measurements from reactors and nuclear power plants with digital computers are presented. The problems encountered concern the proper treatment of the electrical signals received, the signal analysis, and the message forms presented. The various considerations connected with the programming are reviewed. Criteria necessary for the development of a data processing system are summarized. (tr-auth)

26619 NEW NON-LINEAR PULSE-HEIGHT COMPENSATOR **FOR TIME-TO-AMPLITUDE CONVERTERS. Thieberger, P.; Harms-Ringdahl, L. (Research Inst. for Physics, Stockholm). Nucl. Instrum. Methods, 70: 346-8(May 1, 1969).**

The leading-edge timing errors due to pulse-height spread are cancelled by adding to the time-to-amplitude converter output correction signals which are adjustable non-linear functions of the input pulse-heights. With the present device these functions can be easily varied so as to approximate experimentally obtained correction curves. Shown are results obtained with a Ge(Li) γ-ray detector used to perform time measurements with respect to the beam pulses of a cyclotron. Variations in coincidence peak position from 140 keV to 1.4 MeV are readily reduced from 28 nsec to about 0.7 nsec. (auth)

26620 INSTRUMENTAL EFFECTS IN A RETARDING FIELD ENERGY ANALYZER. Wei, Pax S. P.; Kuppermann, Aron (California Inst. of Tech., Pasadena). Rev. Sci. Instrum., 40: 783-5(June 1969).

Measurements of the well known electron impact spectra of helium show that a retarding field energy analyzer can give spurious responses; these can be minimized but not eliminated by careful adjustments of the operating potentials. Probable sources of the trouble are discussed. (auth)

26621 HEAVY-ION ENERGY LOSS SPECTROMETER. Park, John T.; Schowengerdt, F. D. (Univ. of Missouri, Rolla). Rev. Sci. Instrum., 40: 753-60(June 1969).

A high resolution system for the measurement of the energy loss spectra of 20–250 keV heavy ions incident on gas targets is described. The high resolution is obtained by decelerating the ion beam to a low, well defined energy before performing the energy analysis. The energy loss spectrum is determined by changing the accelerator energy to compensate for energy lost in collisions with the gas atoms. The system is arranged so that normal fluctuations in the accelerator's power supply do not affect the energy resolution. The resolving power of the system is 2.5×10^4. The primary proton beam has a detected WHM of 2 V at 50 kV. An energy loss spectrum is shown for which the collision-excited 1^1S-2^1P transition in helium is clearly resolved. (auth)

26622 THE USE OF THE PRINCIPLE OF CROSSED ELECTRIC AND MAGNETIC FIELDS FOR THE REALIZATION OF A SECONDARY ELECTRON MULTIPLIER WITH EXTREMELY HIGH TIME RESOLUTION. Antkowiak, J.; Bernhard, F. (Humboldt-Univ., Berlin). Nucl. Instrum. Methods, 70: 269-73(May 1, 1969). (In German).

The response time of photomultipliers is determined by differences in the time-of-flight of electrons. Minimal differences are achieved in a strong homogeneous electric field. This can be realized in the multiplier with crossed electric and magnetic fields. The response time of this type of multiplier is computed. (auth)

26623 RADIATSIONNAYA TEKHNIKA. VYPUSK 3. (Radiation Technology. Number 3). Voskoboinikova, E. I. Moscow, Atomizdat, 1969. 304p.

Forty three articles are included on theoretical and experimental works in nuclear physics, radiation technology, radioisotopic methods for measuring thickness, density and levels, isotopic thermoelectric generators, industrial radiochemical devices, x-ray diagnostics, radiography, γ defectoscopy, neutron generators and activation analysis. New instruments and devices developed by the All-Union Research Inst. of Radiation Technology are described. 200 references are included. (R.V.J.)

26624 PIVOTABLE MOUNT FOR ELECTRIC FIELD ELECTRODES OF A CYCLOIDAL MASS SPECTROMETER. Erickson, Raymond A. (to Varian Associates). U. S. Patent 3,439,162. Apr. 15, 1969. Filed Mar. 24, 1966.

A cycloidal mass spectrometer is disclosed. The spectrometer includes an evacuated envelope disposed between the pole pieces of a powerful electromagnet and containing an array of axially aligned parallel elongated ring-shaped electrodes for producing a region of electric field at right angles to the dc magnetic field produced by the magnet. An ion source is contained within the envelope for forming and projecting a stream of ions to be analyzed into the region of crossed electric and magnetic fields for mass analysis of the ions. The envelope includes a demountable flange having an electrode support structure for the rings projecting therefrom. The ring electrodes are pivotably mounted from the support structure such that separate ones of the ring electrodes are pivotable out of the array of electrodes for maintenance and pivotable back into an operating position in the array without loss of alignment. (Offic. Gaz.)

26625 MULTIPLE-SOURCE SAMPLE CHAMBER FOR A SURFACE IONISATION MASS SPECTROMETER. Turnbull, A. H. (Atomic Energy Research Establishment, Harwell, Eng.). J. Mass Spectrom. Ion Phys., 1: 409-14(Oct. 1968).

A chamber is described, for use with a surface ionization mass spectrometer which speeds up sample throughput by enabling six samples to be cleaned simultaneously and then analysed consecutively without exposure to atmosphere. (auth)

26626 SENSITIVE RADIO RECEIVER FOR IONOSPHERIC MEASUREMENTS. Szachta, F. D.; Houston, R. E. Jr.; Larson, L. E. (Univ. of New Hampshire, Durham). J. Phys., E (London), 2: 546-8(June 1969).

A small rocket-borne amplitude-modulated radio receiver, developed for use in Faraday rotation experiments which measure the electron density of the lower ionosphere, is described. The receiver performs well over a range of frequencies of 1–4 MHz, has an effective bandwidth of 2.2 kHz and a sensitivity of 5 μv m^{-1}. (auth) (UK)

Radiation Effects on Instruments and Instrument Components

Refer also to abstract 28077.

26627 (AD-676976) NEUTRON DAMAGE TO SILICON SOLAR CELLS. Stofel, Edwin J.; Stewart, Thomas B.; Ornelas, Joseph R. (Aerospace Corp., El Segundo, Calif.). June 1968. Contract F04695-67-C-0158. 51p. (TR-0158(3250-20)-5; SAMSO-TR-68-368). CFSTI.

Silicon solar cells of the n/p 5 to 10 ohm-cm type were irradiated with neutron fluences from 5.2×10^9 to 1.5×10^{13} n/(sq cm) using a TRIGA reactor. Current-voltage characteristics, spectral response, and diffusion length measurements were made and the results interrelated. Agreement with theory is good. Diffusion length depends upon injection level in a manner similar to that for proton irradiation. (auth) (USGRDR)

26628 (BNWL-1025) ESTIMATED READOUT ERRORS PRODUCED BY RADIATION AND TEMPERATURE EFFECTS IN COAXIAL SIGNAL CABLES FOR FFTF. Stringer, J. L.; Bourassa, R. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 1969. Contract AT(45-1)-1830. 28p. Dep. CFSTI.

The problem of nuclear radiation generated currents in signal cables exposed to a radiation field and the change in insulator conductivity caused by radiation have been known and recognized for many years. To date no comprehensive understanding of how the various parameters influence the magnitude and polarity of the signals has been developed. After an analytical model was developed to explain how these currents are generated, experiments were performed in a pulsed TRIGA reactor to evaluate the radiation-induced currents and the induced-conductivity effects on MgO insulated stainless steel coaxial cables. These data are used to estimate the expected readout error from dc sensors located in an environment approximating an FFTF-LMFBR core. Results of these evaluations for stainless steel coaxial cables insulated with MgO indicate that the readout error, due to a radiation field of 5×10^9 R/hr and 1200°F, will be equal to: (% error) = $|IR_s/V| \times 100$, where I = total radiation-induced current, V = sensor output voltage, and R_s = sensor source impedance. These numerical results should not be applied universally, but rather each individual case must be treated independently because of the large difference in induced currents for different cables. (auth)

26629 (N-68-20347) IMPEDANCE CHARACTERISTICS OF IRRADIATED THIN FILMS. Final Report, June 1, 1965–August 31, 1967. Eberline, Roy F.; Glass, David S.; Howard, Lorn L. (Southern Methodist Univ., Dallas, Tex. Inst. of Tech.). Dec. 1, 1967. 75p. (NASA-CR-93772; PR-2). CFSTI.

The complex electrical impedance characteristics of thin (of the order of 1000 A) bismuth films at infrared frequencies corresponding to the region between 2 and 15 microns are discussed. Equivalent electrical circuits are derived for films having initial resistances in the range between 34 and 350 ohms per square, making use of theory from transmission-line analysis and of measurements of film resistance and infrared transmission. The electron beam irradiation of thin conducting films is considered, and particular problems associated with the determination of irradiation-induced characteristics of thin bismuth films are discussed. The development of instrumentations and techniques for solving these problems is presented. (auth) (NSA)

26630 (N-69-10250) THE EFFECTS OF REACTOR RADIATION ON 22-VOLT SILICON VOLTAGE REGULATOR DIODES. Weinstein, Suzanne T. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Nov. 1968. 24p. (NASA-TN-D-4923). CFSTI.

Twenty-five silicon voltage regulator (Zener) diodes (S1N2985B) were exposed to reactor radiation to a total fast neutron fluence of 8.2×10^{13} neutrons per square centimeter and a gamma dose of 6.3×10^7 rads carbon. The Zener voltage remained essentially constant and the breakdown knee was somewhat softened. The forward and reverse-leakage currents increased, and the forward voltage drop at high forward currents increased. The junction capacitance remained unchanged. (auth) (STAR)

26631 (N-69-10933) RESOLUTION CHANGES IN LITHIUM-DRIFTED SILICON SEMICONDUCTOR DETECTORS IRRADIATED WITH 0.5, 1.0, 2.0, AND 3.0 MeV ELECTRONS. Hendricks, Herbert D.; Phillips, Donald H. (National Aeronautics and Space Administration, Langley Station, Va. Langley Research Center). Nov. 1968. 32p. (NASA-TN-D-4901). CFSTI.

Lithium-drifted silicon semiconductor detectors (2 mm deep and 80 mm^2 surface area) were irradiated with 0.5, 1.0, 2.0, and 3.0 MeV electrons. Fluence thresholds for damage were measured by monitoring resolution changes in the 0.972 MeV conversion electrons from ^{207}Bi. The fluence for 100-percent change in detector resolution was found to be approximately 10^{12} e/cm^2. Irradiations with 1 MeV electrons made at 10^7, 10^8, and 10^9 e/cm^2-sec gave no apparent flux dependence in the damage effects. (auth) (STAR)

26632 (N-69-11598) RADIATION EFFECTS ON LITHIUM p ON n SOLAR CELLS. (Lockheed-Georgia Co., Marietta). [1968]. Contract NAS5-10415. 40p. (NASA-CR-97754; ER-9357). CFSTI.

An experimental investigation of the effects of electron radiation on lithium p on n type silicon solar cells is reported. The following parameters were investigated: (1) radiation induced changes in the region of the p-n junction; (2) radiation induced changes in regions far from the junction; and (3) compensation of the changed or damaged areas by lithium ion diffusion. The above parameters occur concurrently and are competing processes. It was assumed that the rate of solar cell degradation is the difference between the rate of introduction of damage centers and the rate of lithium ion compensation of these centers. Furthermore, since the compensation process uses up lithium ions and the lithium ion concentration is finite then the rate of solar cell degradation would increase after long term exposure to a constant electron flux. The rate of lithium ion compensation of radiation damaged sites is affected by several factors. Among these are the operating temperature of the cell, lithium ion drift in the photovoltaic field, lithium ion concentration within the lattice, and lithium precipitation. The cells were irradiated at different temperatures and under different light conditions to give insight into these effects. (auth) (STAR)

26633 (N-69-12245) RADIATION-INDUCED NONLINEAR DEGRADATION OF TRANSISTOR GAIN. Six Month Progress Report, January 4–July 4, 1968. Brown, R. R.; Sivo, L. L. (Boeing Co., Seattle, Wash. Aerospace Group). Contract NAS5-10443. 126p. (NASA-CR-97825; D-2-125680-2). CFSTI.

A short account of the experimental conditions during the 1 MeV electron test is given, including a description of the different transistor groups, the measurements and the exposure conditions. The bulk of the report deals with the analysis of the extensive amount of data obtained during the 1 MeV test. Certain special measurements carried out on selected groups are analyzed against the theoretical background of nonlinear damage as it is understood today. Differences between NPN and PNP, passive and active (during exposure) devices are illustrated and discussed in detail. Other measurements, common to all the devices, give a detailed picture of the dependence of the nonlinear damage upon the emitter current during gain measurements. These measurements also furnished data for a statistical study in which differences in irradiation response among devices within a batch, among batches and between manufacturers were revealed. (auth) (STAR)

26634 (N-69-14918) STUDY OF RADIATION EFFECTS IN LI-DOPED SILICON SOLAR CELLS. Quarterly Report, August–October 1968. Downing, R. G.; Carter, J. R.; Van Atta, W. K. (TRW Systems, Redondo Beach, Calif.). Nov. 15, 1968. Contracts NAS7-100; JPL-952251. 41p. (NASA-CR-98713). CFSTI. For Jet Propulsion Lab., Pasadena, Calif.

Studies of the annealing of irradiated lithium doped crucible silicon solar cells indicate considerable improvement over previous devices with annealing times of the order of 10 days at room temperature. Considerable divergence is evident in the data indicating strong response dependence on subtle manufacturing techniques or material characteristics which are not normally identified. A group of float zone lithium doped solar cells were studied as a function of redistribution time at 250°C. The lithium concentration at the junction is observed to rise rapidly until a maximum is reached after which further redistribution reduces the lithium concentration to an undetectable value. Short circuit current is reduced as the lithium concentration near the junction reaches a maximum value. The short circuit current remains constant thereafter even though the lithium is being depleted from the junction region. Carrier removal studies indicate a deep lying acceptor defect which may be responsible for observations of incomplete annealing of lithium doped cells. (auth) (STAR)

26635 (N-69-14919) ACTION OF LITHIUM IN RADIATION-HARDENED SILICON SOLAR CELLS. Quarterly Report, July 16–October 15, 1968. Brucker, G. J.; Faith, T. J.; Holmes-Siedle, A. G. (Radio Corp. of America, Princeton, N. J. Astro-Electronics Div.). Nov. 15, 1968. Contracts NAS7-100; JPL-952249. 81p. (NASA-CR-98717; AED-R-3389). CFSTI.

Continuing tests on cells irradiated to fluences from 10^{14} to 10^{16}e/cm^2 indicate that to obtain good long-term stability in cells made from silicon of low oxygen content, lithium density should be made as is compatible with maximum cell recovery for the fluence applied to the cells. Pre-irradiation measurements made on quartz crucible cells showed that those with low-lithium-density gradient had tungsten efficiencies with an average of 10.9 percent; a second group with high-lithium gradient had tungsten efficiencies with an average of 7.5 percent. Preliminary measurements on float-zone cells indicate that the lithium diffusion constant in these cells increases with increasing distance from the junction. Hall-coefficient and resistivity measurements were used to investigate the crystal growth and irradiation-temperature dependence of the introduction rate and room-temperature annealing of carrier-removal defects in lithium-doped silicon. Carrier densities measured at or near-room temperature decreased in quartz crucible silicon and increased in float-zone silicon. Crucible-silicon samples annealed to 373°K for 10 minutes exhibited complete recovery of mobility. Complete recovery of mobility in Float-Zone silicon took place in an annealing time ≤17 hours at room temperature. (auth) (STAR)

26636 (N-69-14994) AN INVESTIGATION OF THE EFFECTS OF RADIATION ON SILICON NITRIDE INSULATED GATE (MNS) TRANSISTORS. Final Report. Wegener, H. A. R.; Frank, R.; Sewell, F. (Sperry Rand Research Center, Sudbury, Mass.). May 1968. Contract NAS5-10223. 57p. (NASA-CR-98739; SRRC-CR-67-65). CFSTI.

Early data taken indicated IGFETs using silicon nitride as the gate dielectric were more radiation resistant than IGFETs using silicon dioxide as the gate dielectric. A program was initiated to study empirically the effects of various processing steps on the changes in device parameters brought about by irradiation with 1 MeV electrons. Under this program, several slices of silicon were fabricated for each processing variant. Ten mounted, bonded, and encapsulated devices representative of these slices were then delivered to GSFC for irradiation. The most clear-cut result was the beneficial effect of vacuum baking. The in situ etching also resulted in greater radiation resistance. However, some of the most radiation resistant devices were the result of unknown factors. All devices fabricated were significantly more radiation resistant than commercial MOS transistors. It is recommended that future work be concentrated on structuring the gate and modifying its properties in such a way that more rapid leakage of charge accumulated during radiation is possible. (auth) (STAR)

26637 (N-69-15599) SOLAR CELL RADIATION DAMAGE ON SATELLITES RELAY 1 AND RELAY 2. Waddel, Raymond C. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Dec. 1968. 23p. (NASA-TM-X-63432; X-710-68-474). CFSTI.

Solar cell radiation damage studies on Relay I and Relay II were designed to study, in orbit, the characteristics of several different kinds of solar cells, shielded to various degrees. The results of the experiments reported reflected the character of the spacecraft orbits; the Relay craft spent considerable time in heavily damaging regions of space. A numerical summary of the results is given in tabular form in terms of the times in orbit required for given types of cells to degrade to a given percent of their short circuit currents. Some of the conclusions drawn were: (1) The results from both Relay satellites were similar. (2) Unshielded silicon and gallium arsenide solar cells degraded to the 75% initial short circuit current response level in less than one day. (3) Shields of 19.1 mg/cm^2 extended time to 75% initial response by a factor of at least 100. (4) Silicon n/p cells with 336 mg/cm^2 shields lasted about nine times as long as similarly shielded silicon p/n cells. (5) Unshielded cells showed early damage steps associated with individual orbital passages through a highly damaging region of space; the damage steps were caused by protons whose energies were a few hundred keV and above. (STAR)

26638 (N-69-18074) EFFECTS OF ENERGETIC PARTICLES ON PHOTOMULTIPLIERS IN EARTH ORBITS UP TO 1500 km. Fowler, Walter B.; Reed, Edith I.; Blamont, Jacques E.. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Dec. 1968. 19p. (NASA-TM-X-63419; X-613-68-486). CFSTI.

The response of several types of photomultipliers to energetic particles is discussed in terms of observed background current. Examples are drawn primarily from photometers for observation of the Earth's airglow on two Polar Orbiting Geophysical Observatories, OGO-2 and OGO-4; brief reference is made to other OGO photometers. The largest background current was observed on

OGO-2 from an EMR 541E, a sapphire end-window tube with S-20 photocathode. At a maximum of the inner electron belt, cathode current exceeded 10^{-9} amperes at about 1500 km. Several components were noted in the background current, with the most prominent due to the inner radiation belt and a component with the latitude distribution characteristic of cosmic rays. Estimated instantaneous proton and electron fluxes are compared with background current in order to obtain an approximate responsivity to energetic particles. (auth)

26639 (N–69-19031) STUDY OF RADIATION EFFECTS IN Li-DOPED SILICON SOLAR CELLS. Quarterly Report. Downing, R. G.; Carter, J. R.; Van Atta, W. K. (TRW Systems, Redondo Beach, Calif.). Feb. 14, 1969. Contracts NAS7-100; JPL-952251. 30p. (NASA-CR–100212). CFSTI.

For Jet Propulsion Lab., Pasadena, Calif.

Several groups of lithium doped float zone silicon solar cells were irradiated at two fluences and stored at room temperature. Half recovery times are observed for the corresponding fluences. The maximum annealed values are higher for the lower irradiation fluences but do not exhibit complete annealing in this fluence range. Previous experiments conducted on lithium doped crucible silicon solar cells indicate that, although annealing times are considerably longer, both the initial outputs and the maximum annealed outputs are higher than this group of float zone cells. Further, storage of lithium doped crucible cells at 80° to 100°C produce annealing times comparable to that of this group of lithium doped float zone cells. Lithium diffused silicon varying concentrations exhibit Hall coefficients in agreement with arsenic doped silicon and silicon doped with lithium in the melt. Carrier removal studies of this float zone lithium diffused silicon indicate an exponential dependence on lithium concentration of the carrier removal rate. (auth) (STAR)

26640 (N–69-19059) AN EXPERIMENTAL INVESTIGATION OF RADIATION EFFECTS IN SEMICONDUCTORS. Final Report, January 1962–September 1968. Compton, W. Dale (Illinois Univ., Urbana. Coordinated Science Lab.). Sept. 1968. 16p. (NASA-CR–98835). CFSTI.

A summary of research on the effects of high energy radiation upon the properties of silicon is presented. The studies concentrated upon the measurements of the properties of silicon with emphasis upon the development of new techniques and methods of studying radiation induced defects. All measurements were made upon single crystals. Publications of the important results of this work are listed along with their abstracts. These publications report detailed measurements of the changes in minority carrier lifetimes of silicon with irradiation, of the luminescence arising from electron-hole recombination at defects introduced into silicon by irradiation, of the changes that occur in the conduction of heavily doped germanium with neutron irradiation, and of the study of the tunneling into highly doped semiconductors. The luminescence has been shown to be a very powerful tool for examining the properties of defects whose energy levels are deep in the forbidden band. (auth) (STAR)

26641 EFFECT OF NEUTRONS ON THE PROPERTIES OF [SILICON] DIODES IN SEMI-CONDUCTOR MICROCIRCUITS. Afanas'ev, K. L.; Korshunov, V. D. Elektron. Obrab. Mater., No. 5, 62-6(1968). (In Russian).

The effect of neutron irradiation on the properties of Si of the type used for diodes in semiconductor microcircuits and on the electrical parameters of the diodes themselves was studied. Neutron irradiation led to a sharp rise in the electrical resistance of the Si and to a corresponding fall in the current through the diode for any given applied voltage. On stopping the irradiation the original properties were restored; this process was very slow at room temp. (1% restoration in the first hour). In order to prevent serious changes in the properties of the Si, neutron irradiation should be kept below 10^{14} n/cm^2. (Metals Abstr.)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Basic Processes

Refer also to abstracts 26182, 26212, and 26240.

26642 (UCLA-12-706, pp 25-34) BIOPHYSICS. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology).

An argon laser was obtained for making holograms of cells, and an improved and refined electrophoretic viable cell separator was developed for a fractionation study of human lymphocytes. Studies in biophysical hematology included separation of human leukocytes by centrifugation and size distribution of mouse fetal blood cells. An analytical scheme for the determination of up to 25 elements in dry biological tissue was developed. A practical micro x-ray fluorescence spectrometer suitable for analyzing samples in the 5 to 50 micron diameter range is being constructed. Organelles associated with oocyte differentiation were studied by electron microscopy. Studies were also conducted on elastic properties of fixed and fresh muscle and electron microscopy of L cells grown in lipid-free medium. (H.L.W.)

26643 RADIOIMMUNOASSAY OF BRADYKININ: CHEMICAL MODIFICATION TO ENABLE USE OF RADIOACTIVE IODINE. Goodfriend, Theodore L.; Ball, Dennis L. (Univ. of Wisconsin, Madison). J. Lab. Clin. Med., 73: 501-11(Mar. 1969).

Measurement of bradykinin by radioimmunoassay is complicated by the lack of a readily iodinated residue in the polypeptide. A reagent that adds such a residue (desaminotyrosyl) and the properties of the product of this reagent and bradykinin are described. The iodinated derivatives of desaminotyrosyl-bradykinin and other tyrosine analogues are compared. Sensitive radioimmunoassays are conveniently performed with these radioactive derivatives, but care must be exercised in selecting the best analogue for each antiserum. (auth)

26644 THE RETENTION OF ^{125}I-IMMUNOGLOBULINS, IgG SUBUNITS AND ANTIGEN-ANTIBODY COMPLEXES IN RAT FOOTPADS AND DRAINING LYMPH NODES. Herd, Zana L.; Ada, G. L. (Walter and Eliza Hall Inst. of Medical Research, Melbourne). Aust. J. Exp. Biol. Med. Sci., 47: 63-72(Feb. 1969).

Studies on the retention of ^{125}I-labeled rat and rabbit immunoglobulins and subunits thereof in rat popliteal nodes indicate that the Fc fragment of IgG is important for maintaining a relatively high concentration of this immunoglobulin in lymph nodes. After footpad injections of the immunoglobulins and subunits, an approximate correlation was found between the initial rate of disappearance from the feet and the molecular size of the substances injected. This suggested that a major factor involved in removal of substances from rat footpads is their rate of diffusion. No correlation with molecular weight was found in the retention pattern of immunoglobulin subunits in the popliteal nodes which drained the footpads. Rabbit Fc fragment was retained 50 times better than rabbit Fab fragment in rat nodes three days after injection. Rabbit H chains were retained better than rabbit L chains. A peptide from the Fc region of rabbit heavy chains, C3, showed high retention in rat nodes and was retained better than IgG but not as well as Fc. Rat IgG and IgM were both retained better than rat Fab in rats. Human serum albumin complexes with rabbit anti-human serum albumin IgG was retained at least 10 times better by rat nodes than human serum albumin alone. Human serum albumin bound to rabbit anti-human serum albumin Fab was retained only about twice as well as human serum albumin alone. (auth)

26645 DISTRIBUTION OF ^{125}I-IMMUNOGLOBULINS, IgG SUBUNITS AND ANTIGEN-ANTIBODY COMPLEXES IN RAT LYMPH NODES. Herd, Zana L.; Ada, G. L. (Walter and Eliza Hall Inst. of Medical Research, Melbourne). Aust. J. Exp. Biol. Med. Sci., 47: 73-80(Feb. 1969).

The ability of rabbit IgG to localize in follicles of rat lymph nodes (heterologous system) has been shown to be due to the Fc fragment. Of the rabbit IgG subunits examined, the H chain and Fc fragment showed follicular localization in rats, while the L chain and Fab fragment did not. Two large peptides from the Fc region of the molecule, C3 and C4, also showed follicular localization. Human serum albumin showed follicular localization in rats only when it was complexed with rabbit anti-human serum albumin intact IgG. Complexes of human serum albumin with rabbit anti-human serum albumin Fab fragment did not go to the follicles. When major subunits of rabbits IgG were injected into rabbits (homologous system) results were qualitatively the same as those obtained in rats, with one exception. Rabbit Fab localized in follicles of rabbit nodes. It was also found that rat Fab localized in rat follicles. Purified rat IgM was shown to localize well in rat follicles. All substances examined showed medullary localization. (auth)

26646 AUTORADIOGRAPHIC STUDY OF THE ^{35}S-SULPHATE INCORPORATION INTO THE SMOOTH MUSCLE CELLS OF AORTA. Malyuk, V. I. (Inst. of Zoology, Kiev). Dopov. Akad. Nauk Ukr. RSR, Ser. B, No. 1, 58-62(Jan. 1969). (In Ukrainian).

^{35}S-sulfate was administered to mature rats and the concentration of isotope incorporated into the aorta smooth muscle cells was studied by autoradiography. Part of the vessel sections was subjected to testicular hyaluronidase treatment before covering with emulsion. It was established that the ^{35}S-sulfate uptake by smooth muscle cells is a direct evidence of biological synthesis of sulphated mucopolysaccharides taking place within them. The isotope was almost equally incorporated into the sulphated mucopolysaccharides digested with testicular hyaluronidase, on the one hand, and those being resistant to this treatment, on the other hand. (auth)

26647 METHOD FOR THE THIN-LAYER CHROMATOGRAPHIC SEPARATION OF ^{14}C AND ^{32}P LABELLED METABOLIC PRODUCTS. Feige, B.; Gimmler, H.; Jeschke, W. D.; Simonis, W. (Univ., Wuerzburg, Ger.). J. Chromatogr., 41: 80-90 (Apr. 22, 1969). (In German).

In order to measure ^{14}C- and ^{32}P-labeled metabolic compounds obtained from incorporation experiments with various plant species, a handy method was developed that permits the separation of labeled intermediates of plant metabolism by thin-layer chromatography on cellulose layers. This method is especially suitable for experments with large numbers of samples. A preceding purification of the plant extracts from interfering compounds is not necessary. (auth)

26648 PHAGOCYTOSIS OF COLLOIDAL THORIUM DIOXIDE AND COBALTIC OXIDE BY THE RETICULOENDOTHELIAL SYSTEM OF THE RAT. Kabisch, William T. (American Association for the Advancement of Science, Washington, D. C.). Ann. N. Y. Acad. Sci., 145: 585-94(Dec. 11, 1967).

From Conference on Distribution, Retention, and Late Effects of Thorium Dioxide, New York. See CONF-660422.

The use of Thorotrast and cobaltic oxide (with added cobalt-60 oxide) for quantative investigations of the phagocytic characteristics of several macrophagic organs in the rat is described. At various intervals after intravenous injection of colloidal suspension, various organs and tissues were removed and assayed for radioactivity. The data obtained are presented and their interpretation is discussed. (M.M.B.)

26649 LOGARITHMIC CONVEXITY OF THE WASHOUT FUNCTION IN TRACER KINETICS. Gunn, Robert B.; Patlak, Clifford S.; Hearon, John Z. (National Inst. of Health, Bethesda, Md.). Math. Biosci., 4: No. 1-2, 1-6(Feb. 1969).

The washout function for an open stationary compartment system is shown to be logarithmically convex for a large class of systems, including the passive system. Examples are presented of compartmental washout curves exhibiting regions of logarithmic concavity. (auth)

26650 WASHOUT CURVE IN TRACER KINETICS. Hearon, John Z. (National Inst. of Health, Bethesda, Md.). Math. Biosci., 3: 31-9(Aug. 1968).

It is shown that the washout function for a stationary, open, compartmental system is strictly convex on any closed subinterval of $t \geq 0$. This results from the fact that the quantity of tracer in each compartment is monotone decreasing under the washout conditions. This property of the washout curve is shown to be a special instance of a more general theorem covering, among others, the class of matrices such that $-A$ is an M-matrix. (auth)

26651 UTILIZATION OF RADIOMETRIC ANALYSIS FOR MEASUREMENT OF ACTIVATION ADENYL CYCLASE BY SYMPATHOMIMETIC AMINES. Rigberg, Martin; Vacik, James P.; Shelver, William H. (North Dakota State Univ., Fargo). J. Pharm. Sci., 58: 358-9(Mar. 1969).

A simple new assay utilizing radiolabeled adenosine triphosphate for the measurement of adenyl cyclase activity was developed. The effectiveness of various sympathomimetic amines in activating adenyl cyclase was measured by means of the new assay technique. (auth)

26652 THE DISTRIBUTION OF LABELED ^{14}C-CHOLESTEROL IN TERMINAL PATIENTS AND THE CHOLESTEROL CONTENT IN HUMAN TISSUES. Rabinowitz, J. L.; Myerson, R. M. (Veterans Administration Hospital, Philadelphia). Atompraxis, 14: 477-80(Nov.-Dec. 1968).

Tissue analysis for specific activity of 4-^{14}C-cholesterol was performed in 18 patients who died between 1 day and 15 months after receiving 30 microcuries of 4-^{14}C-cholesterol intravenously. The rate of distribution of 4-^{14}C-cholesterol between serum and tissues varied. Adrenal cortex was first in the ability to concentrate serum cholesterol, followed by liver. Most of the other tissues accumulated cholesterol at a slower rate, attaining some degree of equilibration after 20 days. Arterial intima cholesterol equilibrated very slowly with serum cholesterol. The cholesterol in the cerebellum slowly exchanges with the serum cholesterol. The rest of the nervous tissue is even less active. Large organs (liver, lung, kidney, etc.) show differences in 4-^{14}C-cholesterol specific activity between lobes and/or regions in the range of 10 to 20%. The cholesterol content for sixteen tissues of male cadavers was determined. (auth)

26653 THE EFFECTS OF OUABAIN AND NO EXTERNAL K IONS ON ACTIVE TRANSPORT OF Na IONS FROM THE FROG MUSCLE. Noda, K. (Kurume Univ., Japan). Kurume Med. J., 15: 51-67(Sept. 1968).

The effects of ouabain and no external K ions on the sartorius muscle of frogs were investigated and compared although both caused similar effects on active transport of Na ions. Washout experiments of isotopic Na and flame-photometric determinations of internal ions were made with reference to the effluxes of other ions or to mechanical properties. The changes in these parameters were examined when ouabain was added to or external K ions were eliminated from a bathing solution. The effects of them on Na effluxes from the muscle with normal Na and that with higher Na were also compared. The effect of ouabain was different from that of external K withdrawal with respect to either time dependency or concentration dependency of the change in ion contents. This discrepancy was also held for the effect on muscle contractility. Ouabain influenced net loss of K^+ in K-free Ringer more intensely than on the exchange efflux of K^+ in Ringer. When external K ions were removed or ouabain was added the ^{22}Na efflux was roughly halved; however, depressive effects took place independently. Ouabain demonstrated a concentration effect on the reduction in ^{22}Na efflux but not on the change in ion contents. ^{22}Na efflux that was reduced in K-free Ringer was returned to normal by simple addition of external K even after very long immersion; the mechanism to restore K-dependent Na efflux could be left unchanged for a period as long as 24 hr in the absence of external K ions. This type of recovery was observed without any relation to external Na ions. In addition to the portion of active Na efflux sensitive to external K, there was a separate ouabain-sensitive Na efflux portion. Ouabain exerted no interference on the effect of external K on Na efflux. The depressive effect of ouabain on ^{22}Na efflux was also detected in a medium without external Na ions. The mode of the action of ouabain on Na efflux was explained in a fashion different from that of withdrawal of external K ions. The effects of both were not accredited to simple competition for the same site on the membrane. The decrease in pump activity caused by removal of external K ions was maintained in such a state that a simple addition of K ions promptly resulted in the resuscitation of the pump activity; decrease in pump activity induced by ouabain was followed by qualitative changes in the pump machinery. (TSS) (NSA of Japan)

26654 EFFECT OF PARABENS ON THE PERMEABILITY OF THE BLOOD: BRAIN BARRIER TO WATER-SOLUBLE RADIOPAQUE MEDIA. Strain, William H.; Rivers, Robert J. Jr.; O'Reilly, Richard J.; Danahy, Daniel T.; Thomas, Martin R.; Wilson, Robert M. (Univ. of Rochester, N. Y.). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 105: 404-10(Feb. 1969).

A study of the effect of parabens, preservatives used in one brand of the commercial water-soluble radiopaque media, on the penetration of the radioiodinated media into the primate brain was carried out on Rhesus monkeys. The radioiodinated media were prepared by adding equal amounts of diatrizoic acid ^{125}I to meglumine diatrizoate 60 percent, with and without parabens, and to sodium diatrizoate 50 percent. When all three preparations were studied under comparable conditions by intracarotid injection, the addition of the parabens possibly reduced the penetration of the brain by meglumine diatrizoate slightly, but the differences were not significant. The comparative studies were made on operated anesthetized monkeys by administering 3 ml. injections directly into the exposed carotid artery five min. apart. Following the second injection, each monkey was perfused with normal saline, and the brain and other tissues removed and counted for radioactivity. All brain radioactivity measurements were determined by counting at the conclusion of the study so that direct comparison could be made. An important incidental finding was the discovery that the blood vessels themselves retained significant amounts of the injected contrast media even after perfusion. (auth)

26655 BONE-SEEKING ISOTOPES IN THE STUDY OF CALCIUM METABOLISM AND BONE PATHOPHYSIOLOGY. Tamvakopoulos, Spiros K. (Rhode Island Hospital, Providence). R. I. Med. J., 50: 757-9; 794; 796(1967).

Some uses, methods of study, and external counting procedures for ^{45}Ca, ^{47}Ca, ^{48}Ca, ^{85}Sr, ^{89}Sr, ^{90}Sr, ^{140}Ba, and ^{72}Ga, and their applications to studies of Ca metabolism and skeletal lesions are reviewed briefly. Under normal conditions areas of higher metabolic rate, such as metaphyses, fractures, metastatic bone disease, eosonophilic granuloma or chondroma, osteomyelitic areas, osteogenic carcinoma, and Paget's disease, show relatively high uptake, but the nature of the lesion cannot be specifically determined. The beneficial effect of hormone or x-ray therapy on bone metastases secondary to carcinoma of the breast can be evaluated by decreased uptake of ^{47}Ca demonstrated after treatment. Treatment of data according to kinetic analysis has defined the exact problems to be studied in bone formation and resorption, mineral exchange between body fluids and the skeleton, and turnover and exchange of various nonosseous Ca compartments. The use of osteophilic isotopes such as ^{45}Ca and ^{47}Ca has contributed to an appreciation of these problems, but the nature and extent of bone turnover and the total bone mass in health and in disease are not known. Various approaches to these problems are discussed and evaluated briefly. Inability to discover the physiologically soundest mathematical expression to describe the observed tracer behavior accounts for the present uncertainty over the validity of the results. (BBB)

26656 THE EFFECT OF ENVIRONMENTAL TEMPERATURE ON HEALING OF BONE LESIONS IN THE RAT. I. EFFECT OF ENVIRONMENTAL TEMPERATURE ON MINERAL METABOLISM. Cuthbertson, D. P.; Tilstone, W. J. (Univ. of Glasgow). Quart. J. Exp. Physiol., 53: 422-7(Oct. 1968).

The metabolism of ^{47}Ca and ^{85}Sr was studied in rats subjected to reduced food intake and living at 30°C environmental temperature and relative humidity 22%, compared to controls at 20°C. After three weeks of acclimatization, the rats were injected with ^{85}Sr and measurement of whole-body radioactivity made one, three, five, eight, and 12 days later. There was a significantly greater retention of isotope by the rats at 30°C than by those at 20°C. The blood activity of ^{85}Sr fell more rapidly in the rats at 20°C, after having attained a higher value at the 6-hr period. This finding suggests that the rats at 20°C have a higher turnover of blood Ca than those at 30°C. When animals at the two environmental temperatures were fed equal amounts of food then the whole-body retentions of ^{85}Sr were the same in each group. Mechanisms discriminating against Sr are apparently not thereby involved. (BBB)

26657 THE EFFECT OF ENVIRONMENTAL TEMPERATURE ON HEALING OF BONE LESIONS IN THE RAT. II. THE EFFECT OF BONE INJURY ON MINERAL METABOLISM AT 20° AND 30°C. Cuthbertson, D. P.; Tilstone, W. J. (Univ. of Glasgow). Quart. J. Exp. Physiol., 53: 428-36(Oct. 1968).

The effect of environmental temperature on ^{85}Sr metabolism was studied in rats with bone lesions. Fracture of a radius in rats living at 20°C and 30°C led to a greater whole-body retention by both groups of a dose of ^{85}Sr injected at the time of fracture, compared to the whole-body ^{85}Sr retention found in isothermally housed uninjured controls. A small dental drill-hole lesion of the tibia resulted in an enhanced whole-body retention of ^{85}Sr only in rats living at 30°C. There was evidence of skeletal mobilization of Ca on fracture of a bone in rats at 20°C, but not in those at 30°C. However, there were no histologically observable differences in healing of bone lesions between the two groups of rats. (BBB)

26658 METHOD FOR THE DETERMINATION OF UNSATURATED IRON-BINDING CAPACITY OF SERUM USING RADIOACTIVE IRON AND MAGNESIUM CARBONATE. Brozovich, B. (St. Bartholomew's Hospital, London). J. Clin. Pathol., 21: 183-8(Mar. 1968).

A new method for measuring the unsaturated iron-binding capacity (UIBC) of serum using radioiron with magnesium carbonate as the adsorbing substance is described. The radioiron magnesium carbonate method, compared with earlier methods was shorter and simpler and equally reproducible. Tubes containing 0.5 ml of serum and 1.0 ml of radioiron solution were shaken and left to stand for 5 min at room temperature. Approximately 125 mg of magnesium carbonate was then added and the tubes were shaken vigorously. After centrifugation (2000 rpm for 10 min) 1.0 ml of supernatant was taken for radioactive counting. The UIBC in μg Fe/100 ml of serum was calculated from: (Radioactivity of sample)/(Radioactivity of standard) × 2 × iron content of solution (μg/ml × 100). The suitability of magnesium carbonate for use in a radioactivity method for determination was evaluated. (BBB)

26659 STUDIES ON BURNS. IX. THE DISTRIBUTION AND LOSSES THROUGH THE WOUND OF ^{131}I-ALBUMIN MEASURED BY WHOLE-BODY COUNTING. **Birke, Gunnar; Liljedahl, Sten-Otto; Plantin, Lars-Olof; Reizenstein, Peter (Karolinska Hospital, Stockholm). Acta Chir. Scand., 134: 27-36(1968).**

A method using ^{131}I and whole-body counting was developed for measuring protein loss through burned skin. This represents the first time a whole-body counter was used to measure protein loss. Human albumin obtained after separation on Sephadex G200 of serum from healthy donors was labeled with ^{131}I, and 8 to 15 μCi of ^{131}I-labeled albumin was injected intravenously. Plasma samples were taken 9, 20, and 30 min, 1, 2, and 4 hr and daily thereafter following injection of the dose. The radioactivity was measured in these samples and in 24-hr urine samples. Whole-body counting was performed in a room with walls consisting of a 15-cm steel and a 3-mm lead layer. One scintillation detector with a cylindrical NaI crystal, 12.5 cm in dia and 7.5 cm in height, moved above and another one below the patient. The efficiency of measurement of ^{131}I was about 1%. The curves for plasma activity and whole-body activity began to run parallel after about six to seven days and continued to do so for the period under investigation, 28 days. On an average, 56% of the given dose was distributed extravascularly and 44% intravascularly. The retained dose curves showed good agreement with the curves obtained by whole-body counting. The losses through the skin were well correlated with the extent of the burn and the time after the accident. In the later phase the losses were well correlated to the excisions performed. Even in rather small burns there was up to three wks a marked extravascular distribution of albumin. (BBB)

26660 ABSORPTION OF TRITIATED WATER BY THE CLOACA OF THE DOMESTIC DUCK (ANAS PLATYRHYNCHOS). **Peaker, M.; Wright, A.; Peaker, Stephanie J.; Phillips, J. G. (Univ. of Hong Kong). Physiol. Zool., 41: 461-5(Oct. 1968).**

It was demonstrated that tritium-labeled water is absorbed from the cloaca of the duck, A. platyrhynchos, after water deprivation and after the administration of a load of hypertonic saline that caused nasal secretion. Tritium-labeled water was also detected in the plasma of ducks in positive water balance, but it is not possible to state whether net water absorption occurred in these birds. The maximum count rate occurred 25 to 45 min (mean, 30 min) after the introduction of tritium-labeled saline into the cloaca. In the saline-loaded and water-deprived ducks where no urine was formed, no tritium-labeled saline remained in the cloaca at the end of the experiment. When 0.35 ml of tritium-labeled saline was introduced without loss, calculations from the approximate total volume of body water (estimated at 60% of body weight) and the counting rate at 2 hr indicated that all the tritium-labeled water had equilibrated with the body water over this period. (BBB)

26661 DISTRIBUTION OF CARBON IN HUMAN TOOTH ENAMEL DETERMINED BY CHARGED-PARTICLE ACTIVATION ANALYSIS. Watson, J. E.; Fremlin, J. H.; Stubbins, M. I. (Univ. of Birmingham, Eng.). Caries Res., 1: 318-26(1967).

The 1967 distribution of carbon in human tooth enamel was determined by deuteron-activation analysis by the reaction $^{12}C(d,n)^{13}N$, in conjunction with autoradiography. (Anal. Abstr.) (TSS)

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Refer also to abstracts 26767, 26772, 26774, 26783, 26794, 26830, 26831, 26877, 26881, 26882, 26900, 26920, and 26951.

26662 (CONF-670649-23) VARIATION AS A FUNCTION OF TIME OF THE RELATION BETWEEN THE ^{65}Zn DISTRIBUTED AND THE ORGANIC BURDEN. **Iranzo, E.; Chueca, A.; Garcia del Amo, C.; Santos Ruiz, A. (Madrid Univ. (Spain). Departmento de Bioquimica). [1963]. 20p. (In Spanish). Dep.**

From Symposium on Applications of Radioisotopes, Madrid, Spain.

The variations, as a function of time, of the distribution of ^{65}Zn (administered intraperitoneally) were determined for the following organs of the guinea pig: the whole organism, carcass, skin and hair, brain, eyes, nails, teeth, liver, pancreas, spleen, stomach, intestine, kidney and suprarenal glands, male genitals, lung, and heart. The results showed that the variation of the organic burden of ^{65}Zn from the intraperitoneal administration up to the 75th day follows the relation, $y = 31 \exp(-0.2453t) + 75 \exp(-0.0149t)$. The carcass, and especially the bones, constitute the major deposition of ^{65}Zn, amounting to 58% of the organic burden. The skin and hair constitute the second accumulation center, with a value corresponding to about half of that of the carcass. The kidneys and suprarenal glands occupy third place with an approximate value of 1.5%. The eyes are another accumulation center, but their contribution to the organic burden is only 0.35% because of their small size. The thoracic and abdominal organs show a continuing decrease of ^{65}Zn content. The teeth and brain show variations that are very similar, with a period increasing up to the 22nd day with contents of 5.5% and 0.5%, respectively, and then decreasing slowly to the 140th day with values of 2.9% and 0.27%. (tr-auth)

26663 (NP-tr-1757) INHIBITION OF GASTROINTESTINAL ABSORPTION OF RADIOACTIVE STRONTIUM WITH SOME ION EXCHANGERS. **Kubodera, Akiko; Akamatsu, Yuzuru; Mori, Tetsuro; Tsurufuji, Susumu. Translated by S. G. Brickley (Atomic Energy Research Establishment, Harwell, Eng.), from Yakugaku Zasshi, 87: 719-25(1967). 19p. Dep.**

Investigations were made on sulfonated polystyrene ionexchange resin, phosphonated polystyrene ionexchange resin, and sulfomethylcellulose ion exchanger. The ion exchangers were shaken in suspension with the solution of ^{90}Sr in flasks containing calcium salt in several concentrations. Adsorption of ^{90}Sr by ion exchangers increased with the decrease in the concentration of calcium in the medium. In a medium of physiological concentration (10 m mole) of calcium salt sulfonated polystyrene resin rapidly adsorbed more than 98% of ^{90}Sr. Sodium, calcium, and strontium forms of the resins were administered to rats, mixed in their diet containing ^{90}Sr in the form of calcium strontium carbonate. Calcium form of sulfonated polystyrene resin is the most effective in inhibiting gastrointestinal absorption of ^{90}Sr. The larger the amount of the resin in the diet, the larger was the amount of ^{90}Sr in the feces. A diet containing the resin of the calcium form in 40% of the diet inhibited the absorption to the level of $\frac{1}{2}$ to $\frac{1}{8}$ of the control group. (auth)

26664 (UCLA-12-706, pp 35-43) BIOCHEMISTRY. **(California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology).**

Investigations were conducted on the blood brain barrier by administering ^{14}C-labeled sodium acetate intraperitoneally to rats. It was found that 0.64% of the radioactivity was located in the brain lipids as compared to 0.09% in the liver lipids. Biosynthesis of unsaturated fatty acids by bacilli was studied; emphasis was placed on effects of temperature changes in the medium on the desaturation reaction. The role of creatine phosphate in maintaining the ATP level was studied with the use of fluorodinitrobenzene, a specific inhibitor of the enzyme involved in the transfer of high energy phosphate from creatine phosphate. Muscle tumors developed in mice following injection of muscle tumor cells that had been cultivated in vitro. Methods of maintaining myosin ATPase levels in rat heart cell cultures were developed. Studies were conducted on radiolysis of saturated fatty acids and preparation of authentic dehydrodimers of stearic acid. (H.L.W.)

26665 BLOOD AND SKELETAL LEVELS OF ^{210}Pb–^{210}Po AS A MEASURE OF EXPOSURE TO INHALED RADON DAUGHTER PRODUCTS. **Blanchard, R. L. (Public Health Service, Cincinnati); Archer, V. E.; Saccomanno, G. Health Phys., 16: 585-96(May 1969).**

The concentrations of ^{210}Pb and ^{210}Po in samples of rib and vertebra from 22 uranium miners are compared with the ^{222}Rn daughter exposures. A correction was made for the excretion of ^{210}Pb from the skeleton during the time interval of exposure to the end of their mining experience and to the miners' death. A correlation was observed between the log of the ^{210}Pb concentration in bone and the log of the miners' cumulative exposure adjusted for ^{210}Pb excretion to the end of the mining experience, ($R = 0.92$ ($P < 0.001$)). More ^{210}Pb was observed in the bone than was predictable from exposure to short-lived ^{222}Rn daughters alone, and the possible source of this ^{210}Pb is discussed. In addition, a linear correlation was observed between the ^{210}Pb concentration in blood to that in the bone samples, [$R = 0.85$ ($P = 0.005$)]. The use of blood ^{210}Pb levels to estimate cumulative exposure in a mine atmosphere appears promising, and the possibility is discussed. (auth)

26666 INFLUENCE OF SEX HORMONES AND TISSUES ON COLLOIDAL THORIUM DIOXIDE DISTRIBUTION AND EFFECTS IN RABBITS. **Hyman, Chester; Paldino, Rita L. (Univ. of Southern California, Los Angeles). Ann. N. Y. Acad. Sci., 145: 576-84(Dec. 11, 1967).**

From Conference on Distribution, Retention, and Late Effects of Thorium Dioxide, New York. See CONF-660422.

The interaction between Thorotrast and reticulo-endothelial function was investigated. The circulating albumin of rabbits and rats was labeled by intravenous injection of Evans Blue in amounts that gave no more than five molecules of dye per protein molecule. Arterial blood samples were taken every 20 min for two hrs following administration of the dye. The effects of Thorotrast (administered six hrs previous to the dye) and other factors on the protein disappearance rate were studied. Only Thorotrast particles larger than 1 μ interfered with the disappearance of the protein from circulation. The mechanism of blockage was not clear but may have been related to the swelling of the Kypffer cells and consequent interference with perfusion of liver sinusoids. The Thorotrast blockage was not demonstrable in intact male or in ovariectomized, hysterectomized, or panhysterectomized female rabbits. Removal of the testes or administration of exogenous estrogen to the ovariectomized rabbits restored the effect. The female sex hormone consistently failed to restore the normal effect of thorium dioxide in rabbits lacking a uterus. Similar sex differences and effects of hysterectomy could not be demonstrated in rats. Administration of estrogen in rats increased protein disappearance rates about equally in males and females. Adrenalectomy of either sex of rats increased dye disappearance rates. (M.M.B.)

26667 LOSS OF THORIUM DAUGHTER BY THORIUM DIOXIDE PATIENTS. Hursh, John B. (Univ. of Rochester School of Medicine and Dentistry, N. Y.). Ann. N. Y. Acad. Sci., 145: 634-41(Dec. 11, 1967).

From Conference on Distribution, Retention, and Late Effects of Thorium Dioxide, New York. See CONF-660422.

The excretion patterns in man for daughters of ^{232}Th are described. Advantages and disadvantages of collection of excreta and direct measurement of body loss and tissue or whole-body analysis yielding the ratio of daughter to immediate parent are considered. Data on excretion rates of ^{228}Ra, ^{228}Th, and ^{224}Ra are presented. A special detector is described for measurement of ^{220}Rn in expired air and data for such loss in expired breath of Thorotrast patients are given. Previous results indicate that ^{212}Pb may be excreted by Thorotrast patients. Finally the relation of excretion rates to dose estimates is discussed. (M.M.B.)

26668 MEASUREMENT OF THORIUM AND DAUGHTER PRODUCTS IN TISSUE: EFFECT OF TIME ON THE RESULTS. Goldin, A. S.; Magno, P. J.; Kauffman, P. E.; Coats, G. I. (Public Health Service, Winchester, Mass.). Ann. N. Y. Acad. Sci., 145: 654-9(Dec. 11, 1967).

From Conference on Distribution, Retention, and Late Effects of Thorium Dioxide, New York. See CONF-660422.

A procedure for tissue analysis of Thorotrast patients and data on two autopsies are presented. If samples are to be measured quickly after collection and repetitively over a period of time, non-destructive γ spectrometric analysis is essential. In the thorium series only ^{208}Tl, ^{228}Ac, and ^{212}P emit sufficient gamma radiation for direct measurement. By subsequent measurements over a period of time all the nuclides except ^{232}Th may be determined by calculations from the ^{208}Tl gamma line. After all possible information from γ spectrometry has been obtained the samples may be ashed and ^{232}Th, ^{228}Ra, and ^{228}Th determined chemically. Problems involved in quick examination of biopsy, surgical, and autopsy materials are discussed. The routine use of blood samples from patients receiving whole-body counting is proposed. (M.M.B.)

26669 DISTRIBUTION OF THORIUM DAUGHTERS IN BONE. Jee, Webster S. S. (Univ. of Utah Coll. of Medicine, Salt Lake City); Dockum, Norman L.; Mical, Renon S.; Arnold, James S.; Looney, William B. Ann. N. Y. Acad. Sci., 145: 660-73(Dec. 11, 1967).

From Conference on Distribution, Retention, and Late Effects of Thorium Dioxide, New York. See CONF-660422.

The qualitative and quantitative autoradiographic localization of thorium daughters after injection of thorium dioxide is described. An attempt is made to extrapolate these data to the whole skeleton. Formulae for calculations are listed. Two patients were analyzed, one had received Thorotrast 17 days previously, the other 19 yr. A dog was injected with thorium dioxide 51 days before analysis. The quantity of ^{228}Th in bone was calculated from data obtained by microphotography and visual tract counting of autoradiograms. The total skeletal activity of ^{228}Th as percent of injected ^{232}Th was 1.7% after 17 days and 2.9% after 19 yr. The ^{228}Th and daughters were found to be diffusely but unevenly distributed in bone tissues of both patients. More macrophage-thorium dioxide aggregates lined endosteal surfaces of the patient with the longer burden times. Higher concentrations of alpha tracks were found in trabecular and cortical bone surfaces lined with aggregates (this was interpreted as ^{228}Ra atoms translocating from macrophage-thorium dioxide aggregates). The quantities in cortical and cancellous bones were about 0.62 and 49.0 p Ci/g bone in both patients. The total skeletal activity of ^{228}Th as percent of injected ^{232}Th was 2.9% after 51 days in the dog. A diffuse and hot-spot distribution was found in both cortical and cancellous bones. The average quantity of ^{228}Th was 1.67 and 120 pCi/g of cortical and cancellous bones. The average hotspot to average diffuse ratios were 11.4 for cortical bone and varied between 4.4 to 9.9 for spongy bone. The average diffuse to uniform ratios were between 0.29 to 0.55 for compacta and 0.69 to 1.28 for spongiosa. An appendix presents the number of tracks per disintegration in eight microautoradiograms and the correction for decay of activity from death to mid-counting of autoradiograms. (M.M.B.)

26670 KINETIC REGULARITIES IN THE UPTAKE AND METABOLISM OF RADIOACTIVE ISOTOPES BY THE SEA WEED. Barinov, G. V. pp 190-7 of Voprosy Biookeanografii. Materialy II Mezhdunarodnogo Okeanograficheskogo Kongressa, 30 Maya-9 Iyunya 1966 g, Moskva. Kiev, Izdatel'stvo Naukova Dumka, 1967. (In Russian).

From 2nd International Oceanographic Congress, Moscow, USSR. See CONF-660574.

If a radioisotope is introduced into the habitat of a hydrobiont, after a certain time an equilibrium is established between the activity of the organism, A_s, and the medium A_l; this equilibrium is characterized by a steady-state value of the coefficient $K_s = A_s/A_l$, following the law of distribution between two phases. In simple systems the isotopic metabolic processes follow the exponential law; in complex systems, some other special law prevails. It may be determined by the statistical distribution function of the metabolic rate constants or the energy of activation of the elementary processes. The uptake and metabolism of radioisotopes was studied with isotopes of C, P, Rb, Sr, I, Mn, Y, Cs, and Ce on the brown alga Cystoseira barbata and the green alga Ulva rigida. On the basis of the results, the statistical theory was applied to the complex isotopic metabolism in hydrobiological systems, calculating the fundamental parameters, such as the buildup coefficient, metabolic coefficient, etc. The buildup of a radioisotope was considered as a part of the metabolic and energetic cycle of the element. The derived laws permit clarification of the role of metabolic processes in the biogeochemical cycle of the element. (TTT)

26671 STRONTIUM MOBILITY IN GERMINATING SEEDS AND PLANTS. Creger, C. R.; Allen, W. S. (Texas A and M Univ., College Station). Plant Physiol., 44: 439-41(Mar. 1969).

The uptake of strontium in the bean plant (Phaseolus vulgaris) was linear for the first 34 hr during continuous exposure to radiostrontium. After 35 hr there was a sharp increase in the rate of uptake to 48 hr. Radioactivity could be detected in the plant as early as 1 hr after addition of radiostrontium to the growth medium. Seventy-five percent of the radiostrontium was located in the seed coat immediately after soaking bean seed in an ^{89}Sr solution. This radioactivity in the seed coat decreased rapidly up to the tenth day, while the proportion of strontium in the cotyledons increased, after which time the proportion of radiostrontium in the cotyledons began to decrease. The amount of radioactivity of the seedling axis increased constantly, as did the activity of the first and second leaves after their appearance on about the seventh day. The radioactivity in the developing third and fourth leaves of cotton plants (Gossypium hirsutum) increased at the expense of the radioactivity in the first two leaves and stems. This represents a movement into certain parts and then a retranslocation out of these parts as other tissue begins to develop. (auth)

26672 ULTRASTRUCTURAL LOCALIZATION OF THOROTRAST IN THE RETICULOENDOTHELIAL SYSTEM. Kluge, Trond; Hovig, Torstein (University Inst. of Pathological Anatomy, Oslo). Amer. J. Pathol., 54: 355-71(Mar. 1969).

The accumulation of Thorotrast in the reticuloendothelial system was studied by electron microscopy following injection into the serous cavities of adult rats. At different time intervals, particles were observed in mesothelial cells, lymph capillaries, and in cells of the reticuloendothelial system. In lymph nodes and spleen, particles appeared in macrophages, reticulum cells, and sinusoidal cells. In the liver, both hepatocytes and Kupffer cells were seen to accumulate thorium particles. The intracellular distribution of Thorotrast seemed to follow a general pattern. Initially, the particles were localized in large cytoplasmic vacuoles, probably phagosomes (phagocytic vacuoles); later they accumulated in secondary lysosomes (phagolysosomes) of different types, and were retained in these structures. It is suggested that the lysosomal localization of Thorotrast in reticuloendothelial cells may be related to the carcinogenic and immunologic properties of this substance. (C.O.)

26673 STUDIES ON METABOLISM OF ^{131}I-LABELED METHYL IODIDE. Tanaka, Shigeru; Mochizuk, Yoshio (National Inst. of Radiological Sciences, Chiba, Japan). Radioisotopes (Tokyo), 18: 44-9(Feb. 1969). (In Japanese).

Methyl iodide is one of the chemical forms of radioiodine which is known to be released in reactor accidents or in gaseous effluent from nuclear fuel chemical processing plants. Experiments are reported in which ^{131}I-labeled methyl iodide was administered intratracheally to male Wistar rats to study the metabolism of this substance. The fate of ^{131}I-labeled methyl iodide administered to rats appeared to be very similar to that of radioiodine administered as inorganic iodide. This was confirmed by the comparison of thyroid uptake, extrathyroid retention, biological half-life of the isotope in the thyroid glands and composition of iodinated compounds of the thyroid glands in both groups of rats administered ^{131}I-labeled methyl iodide and Na^{131}I. It appears, therefore, that methyl iodide is broken down rapidly in vivo, and the organically bound iodine being converted to iodide ion. It was also confirmed that the thyroid uptake and total body burden of ^{131}I-labeled methyl iodide could be reduced by the administration of sodium iodide or potassium perchlorate. (NSA of Japan)

26674 ELECTRON MICROSCOPIC STUDY OF DIFFUSION AND RESORPTION OF THORIUM DIOXIDE IN THE COCHLEA OF THE GUINEA PIG. 2. REISSNER'S MEMBRANE. Ilberg, Christoph v. (Univ., Frankfurt am Main). Arch. Klin. Exp. Ohren-, Nasen- Kehlkopfheilk., 100: 426-36(Aug. 20, 1968). (In German).

Distribution of ThO_2 in components of the guinea pig ear was studied 3 min to 4.5 hr after its injection into perilymph and endolymph. It was shown that the connective cell layer and the basement membrane of Reissner's membrane allowed free passage to solute substances up to a size of ThO_2 particles (dia 40 Å). No free diffusion through intercellular spaces of epithelial cells between endo- and perilymph was demonstrated. Active transport of ThO_2 through the epithelial cells by pinocytosis from the perilymph side into the scala media as well as in the opposite direction was observed. Other transcellular transport mechanisms of ThO_2 through epithelial cells are discussed. (BBB)

26675 EFFECT OF A SEASON AND TEMPERATURE ON THE EXTENT OF TRITIUM OXIDE ABSORPTION THROUGH THE SKIN. Khorobrykh, V. V. Gig. Sanit., No. 2, 42-5(Feb. 1969). (In Russian).

The effect of a season of the year and the air temperature on the extent of tritium oxide absorption through the tail skin was studied experimentally over 94 albino female rats, weighing 203 ± 0.9 gm. The specific activity of the solution amounted to 20.3 mCi/ml. Tritium oxide was found to be absorbed in summer 1½ times more than in autumn and 4½ times more than in winter. The main factor affecting the absorption is, apparently, the surrounding air temperature. (auth)

26676 AVAILABILITY OF STABLE MANGANESE AND ^{54}Mn TO THE RICE PLANT IN FLOODED SOIL. Myttenaere, C.; Masset, M. (European Atomic Energy Community, Ispra, Italy). Soil Sci., 107: 296-301(Apr. 1969).

Rice was grown in a flooded soil traced with ^{54}Mn and sampled throughout the growing cycle in order to explain variations in the specific activity of this radioelement within the plant and relate them to the availability of stable and radiomanganese in the soil. The specific activity of ^{54}Mn in the plant was found to decrease with time together with that of the available Mn fraction of the soil. At harvest, the differences observed within the plant were related to the time at which the organs developed and to their function. These differences may be explained by the evolution of the isotopes in the soil and by the low mobility of Mn in the plant. The values obtained for the total aerial part represent an integral of the conditions prevailing during the whole growing cycle and are consequently higher than the roots values. (auth)

26677 EFFECTS OF ^{131}I THYROID IRRADIATION DAMAGE, THYROXINE, AND THIOCYANATE ON RADIOIODINE METABOLISM IN DAIRY COWS. Miller, J. K.; Moss, B. R.; Swanson, E. W. (Univ. of Tennessee, Oak Ridge). Contract AT(40-1)-Gen-242. J. Dairy Sci., 52: 677-83(May 1969).

This investigation utilized seven pairs of identical-twin cows and two nonpaired cows. Thyroid-damaged cows yielded 53% as much milk containing almost twice as much of a radioiodine dose as their normal controls. Other parameters of iodine metabolism as percentages of the control were: ratio of milk radioiodine to plasma nonbound radioiodine, 227; 72-hr thyroid uptake, 17; plasma-bound iodine, 30; and plasma radioiodine half time, 130. Daily subcutaneous injections to cows with thyroid damage of 5 mg thyroxine increased milk yield 24%, heart rate 29%, and plasma-bound iodine 500%, and resulted in reductions of 29% in milk radioiodine, 46% in milk radioiodine to plasma nonbound iodine ratio, and 40% in plasma half life. These changes were partially maintained by feeding 80 mg thyroxine daily. Feeding 10 g/day sodium thiocyanate in addition to injected thyroxine caused further reductions of 72% in milk radioiodine, 73% in milk radioiodine to plasma nonbound radioiodine ratio, and 45% in plasma half life. Thiocyanate alone had no effect on milk yield but decreased milk radioiodine 66%, milk radioiodine to plasma nonbound radioiodine ratio 77%, plasma half life 17% and thyroid uptake 80% in thyroid-damaged cows, and 58, 62, 38, and 87%, respectively, in normal cows. These results indicate an inverse relationship between circulating thyroxine levels and radioiodine secretion into milk. Thiocyanate produces a greater or over-riding effect on milk radioiodine concentrations. (auth)

26678 THE ELUTION OF ^{51}Cr FROM LABELLED LEUKOCYTES: A NEW THEORY. Ronai, Peter M. (Univ. of Sydney). Blood, 33: 408-13(Mar. 1969).

Chromium-51 elutes rapidly from labeled leukocytes and tumor cells both in vitro and in vivo. Eluted ^{51}Cr is dialysable and is not precipitated with trichloracetic acid and it has therefore been assumed to be free chromium which has dissociated from the labeled cellular protein. In vitro studies with ^{51}Cr-labeled albumin have, however, demonstrated the extreme stability of the covalent bond between chromium and protein. Paper electrophoresis experiments are described which show that the ^{51}Cr which elutes from labeled mouse peritoneal cells behaves electrophoretically like ^{51}Cr-labeled peptides and not at all like free ^{51}Cr in either hexavalent or trivalent forms, or ^{51}Cr-labeled lysine and arginine. Whole-body counting studies after the intravenous injection of the various ^{51}Cr preparations into mice indicate that eluted ^{51}Cr and ^{51}Cr-labeled peptides also have similar biologic behavior. Together, the electrophoretic and whole-body counting studies exclude the presence of significant amounts of free ^{51}Cr (either hexavalent or trivalent) in the ^{51}Cr that elutes from labeled cells and supports the hypothesis that ^{51}Cr elution results from turnover of labeled protein within the cell and loss of non-reutilisable labeled protein fragments. Confirmation of this theory would provide a powerful technique for the study of intracellular and extracellular protein metabolism. (auth)

26679 ACCUMULATION OF RADIOIODINE IN THYROIDS OF CHICKENS. Newcomer, W. S. (Oklahoma State Univ., Stillwater). Gen. Comp. Endocrinol., 11: 539-47(Dec. 1968).

Equilibrium of T/S (ratio of concentration of radioiodide in thyroids to that in serum) and accumulation of thyroidal protein-bound radioiodine in chickens under various experimental conditions were compared with predictions based on an open, 3-compartmental model of thyroid function. Mean values for K_b (min^{-1}), the fraction of thyroidal radioiodide which was protein-bound/min for initially short intervals (up to 30 min) after injection of ^{131}I were: 1.1 for control, 4.9 for low-iodine, 0.08 for high-iodine, and 0.25 for thyroxine-injection trials. The K_b value was not constant throughout the entire period (2 to 3 hr) of observation, contrary to prediction from the model; K_b decreased from the initial value by a factor of about 0.5 after equilibration of T/S in all groups except the thyroxine-injection trials. Mean initial values for C_e /m, effective clearance of radioiodide by the thyroid from the serum, were 4.4 μl/min/mg for control, 0.32 for high-iodine, 25 for low-iodine, and 1.7 for thyroxine-injection trials. In accord with prediction of the model, C_e /m decreased from its initial value after equilibration of T/S in all groups except those injected with thyroxine. (BBB)

26680 QUANTITATION OF GASTROINTESTINAL PROTEIN LOSS BY MEANS OF ^{59}Fe-LABELED IRON DEXTRAN. Jarnum, Stig; Westergaard, Henrik; Yssing, Minna; Jensen, Herluf (Rigshospitalet, Copenhagen). Gastroenterology, 55: 229-41(Aug. 1968).

The validity of using ^{59}Fe-labeled dextran, ^{51}Cr-albumin, $^{51}CrCl_3$, and ^{131}I-polyvinylpyrrolidone(PVP) as quantitative test substances for abnormal protein loss was studied in 37 patients with disease conditions causing gastrointestinal protein loss. There was no statistically significant correlation between fecal ^{131}I output following injection of ^{131}I-PVP and serum albumin or the fractional catabolic rate of labeled albumin. With ^{51}Cr-albumin or $^{51}CrCl_3$ there was some correlation between fecal ^{51}Cr excretion and fractional catabolic rate. For ^{59}Fe-labeled dextran, a similar correlation was found. When the catabolic rate was related to the fecal clearance of ^{59}Fe there was a high correlation. A similar high correlation existed between the catabolic rate and fecal clearance of ^{51}Cr. It was concluded that ^{59}Fe-labeled dextran quantized gastrointestinal protein loss. It was far more reliable than ^{131}I-PVP, and was superior to ^{51}Cr-albumin or $^{51}CrCl_3$. It was better suited to evaluate the effect of a treatment which aims at a reduction of the protein loss, and it was particularly practical in pediatric studies because no urinary excretion of ^{59}Fe takes place. (BBB)

26681 WHOLE-BODY SCANNING OF THE RAT SKELETON. Schlegel, D.; Zech, M. A.; Mohr, U. (Univ., Munich). Deut. Zahnaertztl. Z., 23: 68(Jan. 1968). (In German).

The advantages of ^{85}Sr for study of bone metabolism in rats are briefly outlined. This radioisotope facilitates scanning for evidence of hormonal disturbances or in experimentally induced alloxan diabetes, within a period of up to 72 hr after injection of 50 μCi of ^{85}Sr glycerophosphate. The rate of incorporation and the stability of ^{85}Sr binding in bone can be followed at convenient intervals because of the relatively long half time of ^{85}Sr. The quantitative evaluation of ^{85}Sr deposition can be made by whole-body scanning or direct assay of the bones from experimental animals. (BBB) (TSS)

26682 UPTAKE OF ^{54}Mn BY ARK-SHELL MOLLUSC, ANADARA GRANOSA (LINN). Patel, B.; Bhattachiri, P. M. A.; Doshi, G. R. J. Anim. Morphol. Physiol., 13: 158-68(Feb. 1967).

Studies were made on the uptake, loss and retention of ^{54}Mn by Anadara granosa under laboratory conditions. The soft tissues reached apparent equilibrium in three to four days of exposure. The gills and the mantle folds showed the maximum concentration of ^{54}Mn followed by the shell and other soft tissues. The rate of uptake of ^{54}Mn was a function of the wt. of the animal, the smaller the animal the higher was the concentration factor. On return to a non-active medium, the gills lost the activity rather rapidly. Shell retained the most and the gills the least amount of ^{54}Mn after 15 days. The concentration of stable Mn, Zn, K, and gross β activity were also wt. dependent. The mantle folds and the gills showed maximum concentration of Zn and Mn. Chronic concentration factors for Mn and Zn in A. granosa were significantly higher than the acute concentration factors obtained using radioisotopes under laboratory conditions. (Indian Sci. Abstr.)

26683 BINDING OF INORGANIC IODIDE TO THE PLASMA PROTEINS OF TELEOST FISHES. Huang, Chau-ting (Univ. of Alberta, Edmonton); Hickman, Cleveland P. Jr. J. Fish. Res. Board Can., 25: 1651-66(Aug. 1968).

The natural binding of inorganic ^{125}I by plasma proteins was studied in 10 freshwater teleost fishes, 16 marine teleost fishes, three elasmobranchs, one amphibian, one reptile, one bird, two mammals, and two arthropods. Of these, significant binding existed only in species of the order Clupeiformes including Esox lucius (average 80.9% of plasma inorganic ^{125}I was protein-bound at 20°C), Coregonus clupeaformis (average 80.3% bound), Salmo gairdneri (average 84.3% bound), and Thymallus articus (average 81.0% bound). Significant ^{125}I binding was not found in fish of the orders Cypiniformes, Perciformes, Pleuronectiformes, Batrachoidiformes, Gadiformes, Squaliformes, Chimaeriformes, and Rajiformes. Esox lucius and C. clupeaformis showed a small seasonal variation in binding capacity. The plasma of male fish bound significantly more ^{125}I than did the plasma of female fish. Inorganic ^{125}I was found to bind with a plasma albumin-like protein. The binding sites were presumably free cationic groups of basic amino acid residues on the protein molecules. Radioiodine binding was inhibited by NO_3^-, SCN^-, ClO_4^-, and CCl_3COO^-, but not affected by thiourea, thiouracil, and other halide ions. Binding energy of ^{125}I was weak in both E. lucius (–5.98 Kcal/mole) and C. clupeaformis (–6.08 Kcal/mole). (BBB)

26684 ^{65}Zn AND ^{69m}Zn STUDIES IN THE DOG, MONKEY, AND MAN: PROSTATIC SCINTISCANNING. Johnston, Gerald S.; Wade, John C.; Murphy, Gerald P.; Scott, William W. (Walter Reed General Hospital, Washington, D. C.). J. Surg. Res., 8: 528-34(Nov. 1968).

Metabolism and tissue distribution of ^{65}Zn (as the chloride) and ^{69m}Zn (as the chloride and citrate) were studied in 34 dogs, two Rhesus monkeys, and 10 men. Timed concentrations were measured in the blood of all animals, and in the bile, urine, and fresh tissues of 32 dogs and two monkeys. In addition, the influence of castration, timing, testosterone proportionate treatment, pilocarpine administration, and combinations of these factors were studied. When ^{65}Zn was administered intravascularly, it was rapidly removed from the blood with a 5-min half-life, and stabilized at low levels within one hr in dogs, monkeys, and man. Small amounts of radioactivity appeared in urine and remained relatively constant over the first six hr postinjection. Bile radioactivity increased rapidly and then fell gradually, indicating some excretion of ^{65}Zn by the liver. Tissue assay for radioisotopic concentration (wet tissue) showed the liver, prostate, and renal cortex to contain the greatest amount of radioactivity at six hr. Two weeks after castration ^{65}Zn concentration by the dog prostate was not measurably affected, but responsiveness to testosterone was influenced by castration. Testosterone proprionate injections enhanced the prostatic ^{65}Zn concentration markedly. The results of studies using ^{69m}Zn indicated that prostatic scintiscanning can be used as an adjunctive urological test. (BBB)

26685 ACTIVITY OF α-HYDROXYBUTYRATE-DEHYDROGENASE IN HOMOGENIZED FRACTIONS OF RAT KIDNEYS AFTER EXPERIMENTAL INTOXICATION WITH URANYL NITRATE. Bastide, Janine; Bastide, Pierre (Faculte Mixte de Medecine et de Pharmacie, Clermont-Ferrand, France. CRNS, Clermont-Ferrand, France). Compt. Rend. Soc. Biol., 162: 1492-3(1968). (In French).

The largest part of the α-hydroxybutyrate dehydrogenase activity of homogenized rat kidneys was found in the supernatant following centrifugation at 24,000 g for 2 hrs. In this fraction the activity decreased regularly during experimental intoxication with uranyl nitrate, whereas the content in proteins, DNA, and RNA were relatively slight and underwent only slight variations. (tr-auth)

Radiation Effects

Refer also to abstracts 26719, 26821, 26830, 26871, 26906, 26909, 26935, 26977, and 28561.

26686 (NP-17819, Chap.3.3) RADIOBIOLOGY. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)). 12p.

Research activities in the department of radiobiology are described. The reports are categorized into four sections: Pathology; involving studies of radiation effects at the molecular, cellular, and organismic levels, Physiological Chemistry; devoted mainly to the study of the mechanisms by which x radiation inhibits DNA synthesis in regenerating liver of rats, Cellular Biochemistry; studies of the uptake and fate of foreign DNAs in living organisms, and Phytobiology and Agronomy; involving studies of radiation effects on plants and the radioactive contamination of plants and cow's milk. (E.R.B.)

26687 (UCLA-12-706, pp 45-72) RADIOBIOLOGY. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology).

Formation, decay, and absorption spectra of transient species produced by reaction of OH free radicals with DNA and nucleic acid constituents were investigated by pulse radiolysis. It was found that thymine, uracil, deoxyribose, and thymidine transients have complex decay patterns that vary with pH. Pulse radiolysis studies were also conducted on aqueous pyrimidine base solutions. The pulse radiolysis technique was used for studies on aqueous solutions of DNA and related compounds in the presence of cysteine and oxygen. Studies were conducted on the chemical basis of radiation sensitization of cells by 5-bromouracil substitution in DNA. An electron spin resonance study was conducted on trapped electrons in irradiated frozen sugar solutions. Steady state and pulse radiolysis of aqueous chloride solutions of nucleic acid components were studied. Effects of the chloride ion on the radiation induced destruction of pyrimidines were determined. Degradation of DNA by irradiation was measured after enzymatic hydrolysis. N-ethyl maleimide is known to sensitize bacterial and mammalian cells to the lethal effects of ionizing radiation; a model system was used to investigate the NEM effect at a radiation chemical level. Vibrational structure in the near ultraviolet circular dichroism and absorption spectra of phenylalanine and its derivatives were analyzed. Mechanisms of radiation damage in the mammalian fetus and neonate were investigated. A method for estimation of purified RNA using cupric ion catalyzed orcinol was investigated and improved. Investigations were carried out on organ specific estrogen-induced RNA synthesis resolved by DNA-RNA hybridization in the domestic fowl. Factors affecting the development of glycerolphosphate dehydrogenase in the differentiating rat brain were studied, and the effects of ionizing radiation on the hydrocortisone induction of brain glycerolphosphate dehydrogenase were studied. Effects of ionizing radiation on nucleic acids in the developing rat brain were examined. Brain differentiation parameters in an established line of glial cells in culture were studied. Hypoxia-induced polycythemic mice were evaluated for erythropoietin bio-assay. The additive response of Ehrlich Ascites tumor in mice to gamma radiation combined with DL-glyceraldehyde or methylglyoxal was studied. Studies on effects of salt stress in rats given a single dose of ^{203}Hg-chlormerodrin showed that life spans were significantly shortened regardless of the level of ^{203}Hg given. (H.L.W.)

26688 X-RAY INACTIVATION OF UREASE IN DULUTE SOLUTION. Gorin, G.; Seth, T. D.; Tai, L. W.; Kolenbrander, H. M. (Oklahoma State Univ., Stillwater). Int. J. Radiat. Biol., 15: 23-32(1969).

The inactivation of jack-bean urease was measured in the following conditions: 50–500 μg/ml in 0.05 M phosphate buffer, pH 7, 0°C, in the presence of air. The yield is 0.015 molecules/(100 eV). This value is low, but the weight of enzyme inactivated per unit dose, 7.4×10^{-11} g/erg, is similar to that found for many other enzymes. It is suggested that some functional groups in the urease molecule can react with radicals from the solvent without loss of the enzymatic activity. Repair reactions may be taking place, which consume radicals without causing any permanent changes in the enzyme. (auth)

26689 EFFECT OF DIFFERENT DOSES OF UV-IRRADIATION ON SOME BLOOD INDICES. Isaenko, V. I. (Inst. of Physiology, Kiev). Fiziol. Zh., Akad. Nauk Ukr. RSR, 15: 128-32(Jan. Feb. 1969). (In Ukrainian).

Studies were made of changes in protein and mineral composition (Ca, K, and Na) in the blood serum of dogs irradiated with various doses of ultraviolet. Tabulated data are given on the concentrations of protein and its fractions following various doses of ultraviolet radiation. (R.V.J.)

26690 KINETIC ISOTOPE EFFECT IN THE PHOTOREACTIVATION OF U.V.–INACTIVATED TOBACCO MOSAIC VIRUS RNA. Evans, N. A.; McLaren, A. D. (Univ. of California, Berkeley). Contract AT(11-1)-34. Photochem. Photobiol., 9: 243-6(Mar. 1969).

Inactivation of tobacco mosaic virus RNA (TMV–RNA) by uv radiation is slower in D_2O than in H_2O, and TMV–RNA that was inactivated in D_2O is photoreactivated faster (on Pinto bean) than TMV–RNA that was inactivated in H_2O. The maximum amount of photoreactivation is unaffected by the solvent, H_2O or D_2O, present during irradiation. These deuterium isotope effects for inactivation and photoreactivation suggest that pyrimidine hydrates are photoreactivable lesions on Pinto bean. (auth)

26691 EFFECTS OF SLOW PROTONS ON INFECTIOUS DNA OF BACTERIOPHAGE ΦX174. Jung, Horst; Kuerzinger, Klaus (Kernforschungszentrum, Karlsruhe, Ger.). Z. Naturforsch., 24b: 328-32(Mar. 1969). (In German).

Dry infectious DNA of bacteriophage ΦX174 was irradiated in extremely thin layers with slow protons and the differential inactivation cross section determined for various proton energies in the range from 0.8 to 50 keV. Above 5 keV the inactivation cross section was independent of proton energy, it reached a shallow minimum between 1 and 1.5 keV, and increased slightly at still smaller energies. By comparing the experimentally determined inactivation cross sections with the cross sections for energy loss in elastic nuclear collisions and in ionizations, respectively, elastic collisions were demonstrated to destroy the ability of ΦX-DNA to give rise to intact bacteriophage in spheroplasts of *E. coli* K12. (auth)

26692 RADIATION PRODUCES BREAKS IN L CELL AND MOUSE LIVER DNA CHARACTERIZED BY 5' PHOSPHORYL TERMINI. Dalrymple, Glenn V.; Sanders, J. L.; Moss, A. J. Jr.; Baker, Max L.; Wilkinson, K. P. (Univ. of Arkansas, Little Rock. Veterans Administration Hospital, Little Rock, Ark.). Biochem. Biophys. Res. Commun., 35: 300-5(Apr. 29, 1969).

Using the polynucleotide kinase method, the repair of x-radio-induced DNA breaks in mouse liver DNA and in L cells was demonstrated. The specificity of the enzyme indicates the breaks to have 5' phosphoryl termini. (auth)

26693 EARLY CHANGES OF PLASMA PROTEINS FOLLOWING ISOLATED RADIATION OF THE LIVER. Staehler, Fritz; Otten, Gerhard (Univ., Hamburg). Strahlentherapie, 136: 718-22(Dec. 1968). (In German).

With a new method the plasma protein concentration in rats was reduced to 25% of its original value. Already 48 hours after the exchange transfusion, the normal values are reestablished. An irradiation of the liver with doses of 1000 to 5000 rad does not influence this phenomenon. Studying separatively the albumins and globulins a slow increase of the albumins was noticed compared to a more rapid increase of the globulins. (auth)

26694 TOPOCHEMICAL DETERMINATION OF GLYCOGEN AND MUCOPOLYSACCHARIDES IN THE BRAIN OF GUINEA PIGS AFTER TELECOBALT RADIATION. Selle, Gerhard; Lierse, Werner; Franke, Herbert D. (Univ., Hamburg). Strahlentherapie, 136: 712-17(Dec. 1968).

An histochemical study was done of glycogen and mucopolysaccharides in the ganglionnar and glial cells of the brain of guinea pigs, 24 hours after 100 to 5000 R (^{60}Co). The sensitivity, from the histochemical point of view is of decreasing order as follows: cortex of cerebellum, cortex of brain, modulla oblongata and Ammon formation, thalamus, and corpus striatum. Glycogen is observed after low doses (750 R), whereas mucopolysaccharides after higher doses (2000 R). Macrophages charged with metabolic products (PAS positive substance) are observed mostly after 2000 to 3000 R. The number of necrotic ganglial cells increases in all parts with the dose. Capillary lesions are less frequent than after roentgen irradiation with 200 kV. (auth)

26695 BEHAVIOR OF NUCLEIC ACID METABOLISM IN THE EARLY STAGE OF COMPENSATORY AND REGENERATIVE HYPERTROPHIC GROWTH OF THE KIDNEY AFTER ^{60}Co RADIATION. Bogatzki, Marianne; Evers, Robert; Herzer, Joerg Alexander; Schnepper, Elmar; Schuetz, Juergen (Univ., Muenster, Ger.). Strahlentherapie, 136: 694-9(Dec. 1968). (In German).

The concentration of DNA and RNA in the homogenates, and the activity of DNAase I and II in the different cellular particles was measured in the kidney, in compensatory hypertrophy. These studies are part of experiments where an hypertrophic growth is provoked by telecobalt radiation (Siemens Gammatron). Whereas the DNA content of the hypertrophic renal tissue increases only slowly, and is reduced only a little after an irradiation with high doses, the RNA content is clearly elevated. The RNA/DNA quotient of the tissue increases linearly according to the tissue injury. The activity of the DNAase increases, particularly of the neutral DNAase I. This can possibly lead, by influence on the nuclear heterochromatine, to more free genetic information for the biosynthesis of specific ribo-nucleic acids. Such should be of high importance for the regulation of the protein metabolism. (auth)

26696 INACTIVATION OF TRANSFORMING DNA BY ULTRAVIOLET IRRADIATION: A STUDY WITH ULTRAVIOLET-SENSITIVE MUTANTS OF BACILLUS SUBTILIS. Munakata, Nobuo; Ikeda, Yonosuke (Tokyo Univ.). Mutat. Res., 7: 133-9 (Mar.-Apr. 1969).

The problem of differential inactivation of genetic markers by uv light was studied with uv-sensitive mutants of *Bacillus subtilis*. One uv-supersensitive strain (uvss) and three uv-sensitive strains (uvs) proved to be host-cell reactivation negative. When exposed to uv-irradiated DNA, the uvs strains yielded smaller numbers of transformants than the parental strain (uvr), but the numbers were considerably larger than those of the uvss strain. A linear relationship was found between the average numbers of hits per genetic unit of length and the uv doses. The number of hits induced by uv in a marker was estimated from the number of transformants assayed on the uvss strain and was termed total damage of the marker. The total damage was large in the uv-sensitive marker (asp_6^+) and small in the uv-resistant markers (met_{14}^+ and sfr). This term was used to interpret the differential inactivation of markers by uv light. (auth)

26697 EFFECTS OF PARTIAL HEPATECTOMY, OF TOTAL-BODY X IRRADIATION, AND OF AET ON THE CYTIDINE PHOSPHORYLATING KINASES IN RAT LIVER. Baugnet-Mahieu, L.; Goutier, R.; Semal, M. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). Arch. Int. Physiol. Biochim., 75: 579-92(Sept. 1967).

Earlier studies of the thymidine (TdR) phosphorylating kinases in irradiated regenerating liver indicated that the activity of the enzymes was less radiosensitive than their synthesis. Attempts were made to corroborate this conclusion by studying the effect of x irradiation on the activity of enzymes which, contrary to TdR-kinases, are not synthesized *de novo* after partial hepatectomy: the cytidine (CR) phosphorylating kinases. Partial hepatectomy induced a 30% increase in CR-phosphorylating kinase activities which remained at the same elevated level from 12 to 40 hr after partial hepatectomy. An x-ray dose of 1000 R was administered to rats 1½ hr or 2 hr after hepatectomy. Nonhepatectomized rats were submitted to the same dose of x rays at the same time and were killed either 24½ or 21 hr after irradiation. A slight, but significant inhibition of the enzymatic activity was observed in each case and the effect was of the same order of magnitude with normal as with regenerating liver extracts. Since total-body irradiation exerted, after 24 hr, a relatively small inhibitory effect on CR kinases, the inhibition being the same in normal and in regenerating liver, irradiation evidently interferes more with synthesis or turnover of enzyme molecules than with enzyme activity. Injection of protective dose of the sulfhydryl radioprotector AET inhibited CR kinase activities to the same extent as an irradiation by 1000 R. (BBB)

26698 CHANGES IN THE AMINO ACID COMPOSITION OF THE ADRENAL GLANDS IN ACUTE RADIATION SICKNESS. Podil'chak, M. D. Vrach. Delo., No. 3, 70-2(Mar. 1968). (In Russian).

A paper electrophoresis study of the amino acid content of adrenal hydrolysates of irradiated rabbits revealed a decrease as compared with the control. Cystine, arginine, histidine, thyrosine, valin + methionin, leucin + isoleucin showed the lowest figures. The quantitative amino acid changes depended on the stage of the experiment and were most marked in the acutest stage of radiation sickness. The above changes are explained by morphological and functional lesions of the adrenals due to irradiation. These lesions have a certain effect on the course and outcome of radiation sickness. (auth)

26699 THE ACTIVITY OF SOME THYMIC EXTRACTS ON HEPATIC NUCLEIC ACIDS AND β-GLUCURONIDASE IN THE THYMUS OF IRRADIATED MICE. Potop, I.; Juvina, E.; Biner, J.; Mreana, G. Stud. Cercet. Endocrinol., 13: 411-16(1967). (In Rumanian).

Nucleic acid metabolism and the activity of β-glucuoronidase were studied in x-irradiated mice treated with protein and lipid extracts. Irradiation induced a fall in the metabolism of hepatic nucleic acids simultaneously with a decrease of β-glucuronidase activity in the thymus. By the administration of thymic extracts, normal values were recorded. (auth) (Rom. Sci. Abstr.)

26700 BEHAVIOR OF SERUM PROTEINS IN GUINEA PIGS EXPOSED FOR LONG PERIODS TO RADIOFREQUENCY RADIATION. Swiecicki, W. Med. Pracy, 18: 471-7(1967). (In Polish).

Thirty male guinea pigs were exposed for three hrs per day for three months to radiation at radiofrequencies with a wavelength of 10 cm and energy density of 5 mW/cm^2. Total protein levels were determined by the biuret reaction, and the protein and globulin fraction contents by paper electrophoresis. A distinct increase in the total protein and gamma globulin level was observed in guinea pigs exposed to pulsed radiofrequency energy. No significant change was observed with continuous wave radiation. Consequently the biological effects of this radiation depend not only on the average energy and wave-length, but also on modulation. Analysis of serum protein behavior may therefore be useful in determining the organic effects of radiofrequency radiation. (CIS)

26701 ON THE INFLUENCE OF WHOLE-BODY X-IRRADIATION ON GLYCOGEN METABOLISM IN MOUSE LIVER. **Berndt, J. (Univ., Freiburg i. B.). Atomkernenergie, 14: 57-60(Jan.-Feb. 1969).**

It is well known that in the liver of x-irradiated starved mice the content of glycogen is highly increased, while in control livers of fasted mice the glycogen content is very low. The increased liver glycogen in irradiated mice may have two reasons: diminished glycolysis or enhanced gluconeogenesis. Therefore, the specific activities of the enzymes phosphofructokinase (PFK), pyruvatekinase (PK), fructose-1,6-diphosphatase (FDPase) and phosphoenolpyruvate-carboxykinase (PEP-CK) were measured over a period of 14 days after whole body x irradiation in the liver of 24 h starved mice. The results showed an increase in the specific activities of the two glycolytic enzymes PK and PFK at the time of high glycogen content. However, the two gluconeogenic enzymes FDPase and PEP-CK were also increased at that time, but to a lesser extent. The ratios of PFK: FDPase and PK: PEP-CK followed almost the same pattern and were shifted in favor of glycolysis especially at the late days after irradiation. Gluconeogenesis in its normal manner seemed to be rather low at the time of the high glycogen content. Possibly other than the usual metabolites become more important as precursors of glucose after irradiation. This assumption was put forward because of the fact that the α-glycerophosphate content in mouse liver was highly increased after x irradiation, and because labeled glycerol was incorporated into glycogen at a remarkable rate. (auth)

26702 EFFECT OF ULTRAVIOLET LIGHT ON SOME DEHYDROGENASE ACTIVITIES IN THE EPIDERMIS OF THE RHESUS MONKEY (MACACA MULATTA). **Michael, J. C. (Regional Primate Research Center, Beaverton, Oreg.). J. Invest. Dermatol., 52: 329-32(Apr. 1969).**

Fluorometric microenzyme assay with 0.5 to 2 μg tissue sample in 10 to 15 μl of an appropriate reaction mixture provided a sufficient measurement of enzyme activities in the limited area of irradiated epidermis. The epidermis of the back skin irradiated by 10 erythema doses of ultraviolet light responded with initial slight decreases in all of the 6 enzymes within the first 48 hours followed by a 2-fold increase 72 hours after irradiation. The nonirradiated epidermis seemed to be affected by the irradiation of symmetrical back skin, showing enzyme activities that fluctuated during the recovery from the radiation injury, but to lesser degree than the irradiated epidermis. (auth)

Immunology

Refer also to abstract 26972.

26703 (AD-674502) CYTOTOXICITY OF BEE VENOM AND SOME OF ITS CHROMATOGRAPHIC FRACTIONS FOR MOUSE BONE MARROW STEM CELLS. Cole, Leonard J.; Shipman, William H. (Naval Radiological Defense Lab., San Francisco, Calif.). Sept. 20, 1968. 17p. (USNRDL-TR-68-82). CFSTI.

Mouse bone marrow cells were incubated (37 for 30 min) in the presence of bee venom, and then assayed for their ability to form hemopoietic splenic colonies when transfused into lethally x-irradiated recipient mice. It was found that at honey bee venom concentrations as low as 0.5 micrograms/ml (0.5 part per million by weight) the colony-forming ability of the marrow cells was annulled. Three constituents of bee venom, i.e., melittin, phospholipase A, and a surface-active fraction, separated and isolated by methods of Sephadex gel filtration chromatography were also evaluated for cytotoxicity on bone marrow cells. A marked decrease in yield of splenic colonies was observed with melittin and with the surfactant fraction at concentrations of one microgram/ml, and the phospholipase A fraction was inhibitory at 4 micrograms/ml. It was found also that the synthetic cationic detergent, Cyncal, (a quaternary amine) was cytotoxic for mouse bone marrow cells at 2 parts per million, whereas the non-ionic detergent, "Triton X-100," did not inactivate the marrow stem cells at 10 parts per million. The basis for this potent biological effect of bee venom at the cellular level is briefly discussed; it is suggested that the cellular toxicity is mediated via effects at the cell surface. (TAB)

26704 (CEA-CONF-1105) PROBLEMS CONNECTED WITH THE DEVELOPMENT OF NEW RADIOPHARMACEUTICALS. Douis, M.; Hegesippe, H. (Commissariat a l'Energie Atomique, Saclay (France). [Centre d'Etudes Nucleaires]); Rosa, U.; Scassellati, G. A. (Societa Ricerche Impianti Nucleari, Saluggia (Italy). Centro Ricerche Nucleari). [1968]. 18p. (CONF-680933-2). Dep.

From Nuclear Medicine Meetings, Wiesbaden, Germany.

The stability of ^{125}I-labeled insulin and human growth hormone for radioimmunoassay of these hormones in biological fluids was tested. It was concluded that the labeled growth hormone and insulin were stable for 20 and 60 days, respectively. A simple procedure is described for the preparation of ^{99}Tc colloids and ^{113}In suitable for use in liver scanning. (C.H.)

26705 REACTIONS OF THE GRAFT VERSUS HOST (GVH) TYPE. **Lafferty, K. J.; Jones, M. A. S. (Australian National Univ., Canberra). Aust. J. Exp. Biol. Med. Sci., 47: 17-54 (Feb. 1969).**

Normal lymphoid cells obtained from animals that are phylogenetically unrelated or only distantly related to the chicken do not initiate graft versus host reactions when introduced into chicken embryos. Such cells are capable of mounting a reaction against the embryo if the donor animal is first immunized with chicken tissues. However, the reaction produced by immune xenogeneic lymphoid cells has a different pathogenesis to that produced by normal allogeneic cells. The transfer of adult blood leucocytes to syngeneic embryos will confer on the embryo the ability to reject transplanted allogeneic tissue, but will not confer on the embryo the ability to make antibody or to reject the transplants of some xenogeneic tissues. The latter type of transplant can be rejected if cells allogeneic with respect to the graft are introduced into the embryo. Allogeneic transplants are only rejected by embryos treated with adult blood leucocytes if the transplant contains a relatively large component of reticular tissue. Treatments, such as γ irradiation, that reduce the amount of reticular tissue in the graft protect it from transplantation damage in treated embryos. The in vitro interaction between populations of lymphocytes obtained from different animals has the same specificity as graft versus host reactions in so far as lymphocyte populations obtained from sheep are not stimulated by lymphocytes obtained from a different species of animal such as the rat or goose, but are stimulated by allogeneic lymphocytes. The treatment of one population of sheep lymphocytes with γ rays will destroy their capacity to stimulate allogeneic lymphocytes without affecting the antigenicity of the lymphocytes. It is suggested that the ability of an animal to distinguish between "self" and "not-self" components may operate at two distinct levels; one involves the recognition of foreign antigens, and the other the recognition of cells derived from genetically related but not identical animals. (auth)

26706 IN VITRO ANTIBODY SYNTHESIS BY DIFFUSION CHAMBER CULTURES OF SPLEEN CELLS. I. METHODS AND EFFECT OF 10,000 r ON ANTIBODY SYNTHESIS. **Vann, Douglas C.; Makinodan, T. (Oak Ridge National Lab., Tenn.). J. Immunol., 102: 442-50(Feb. 1969).**

Techniques for the study of antibody production by primed antigen-stimulated spleen cells in cell-impermeable diffusion chambers were developed. The chambers were recovered from their host animals and incubated in vitro with radioactive amino acids. Antibody production was measured by determining the amount of radioactivity that would specifically bind to erythrocyte stroma of the type used for immunization. In addition, the effect of kiloroentgen doses of radiation on antibody production by plateau phase cultures was studied in a system in which primed spleen cells in cell-impermeable diffusion chambers were irradiated six days after antigen stimulation. One and three days later the chamber cultures were incubated in vitro in the presence of ^{14}C-labeled amino acids. The incorporation of radioactivity into total extracellular proteins, γG-globulin, and specific antibody was measured. Isotope incorporation in cultures which had received 10,000 r of x radiation was qualitatively and quantitatively similar to that by unirradiated controls — as judged by a variety of criteria. It was shown previously that irradiation of diffusion chamber cultures of antigen-stimulated spleen cells with kiloroentgen doses of x radiation in the plateau phase of their response leads to a purification of mature antibody-producing cells and virtually eliminates cell multiplication. It was shown here that the surviving immunocompetent cells are as efficient as unirradiated cells in synthesizing antibodies. Thus, it appears that heavily irradiated cultures of lymphoid cells should be useful for further biochemical studies of antibody synthesis and regulation. (auth)

26707 ANALYSIS OF THE PROTECTIVE CAPACITY OF UV-IRRADIATED POLYOMA WITH RESPECT TO TRANSPLANTED POLYOMA TUMOR. Meyer, G.; Lherisson, A. M.; Fondarai, J. (Groupe de Recherches Scientifiques sur les Tumeurs Humaines, Marseille. Centre Regional de Lutte Contre le Cancer, Marseille). Compt. Rend. Soc. Biol., 162: 1535-8(1968). (In French).

The effects of uv irradiation of Polyoma viruses growing in cultured mouse embryo cells on the induction of Polyoma tumors following transplantation of various numbers of infected cells into hamsters and mice were studied. The effects of dose and the number of cells injected are considered. It was concluded that exposure to uv radiation caused a decrease in the rate of replication of the virus and also caused an increase in antigenic rejection of the cells by the host animals. (C.H.)

Ecology

Refer also to abstracts 26670, 26770, 26774, and 26830.

26708 (BMI-171-115) ASPECTS OF BENTHIC MARINE ALGAL ECOLOGY AT AMCHITKA ISLAND, ALASKA. Weinmann, Fredrick C. (Washington Univ., Seattle. Fisheries Research Inst.). Jan. 1969. Contract AT(26-1)-171. 53p. Dep. CFSTI. For Battelle Memorial Inst., Columbus, Ohio.

Descriptive aspects of the benthic marine algal ecology at Amchitka Island, Alaska, were studied by use of vertical transects on intertidal areas and quadrat sampling of the major algal associations. Dry weight determinations were made for the major species collected along the transect lines to obtain estimations of quantitative distributions. The term benchflat measurement is introduced to emphasize characteristics of species distribution on flat rock benches which extend as much as one-fourth mile out to sea at ebb tide with little or no change in vertical height. In addition, some general features of the algal associations occurring in subtidal areas were studied by utilization of scuba-diving techniques. Intertidal areas can be divided into three major regions which correspond with previously established concepts concerning universal features of zonation. The littoral fringe is subdivided into a Prasiola borealis zone, a Rhodochorton purpureum zone, and a Porphyra—Ulothrix zone. The eulittoral region which extends over the flat bench areas has the greatest diversity of species and can be subdivided into a Fucus distichus zone, a Halosaccion—Hedophyllum zone, and an Alaria crispa zone. The sublittoral fringe is dominated by Laminaria longipes. Dense populations of Laminaria spp. with an undergrowth of numerous red algal species dominate the subtidal region to depths of about six meters. In slightly deeper regions to about ten meters Alaria fistulosa forms offshore kelp beds while encrusting coralline algae cover large expanses of the sea bottom to depths of at least twenty meters. (auth)

26709 (BMI-171-116) BIOENVIRONMENTAL SAFETY STUDIES, AMCHITKA ISLAND, ALASKA. Progress Report for FY 1968. Amchitka Bioenvironmental Program. Kirkwood, James B. (Battelle Memorial Inst., Columbus, Ohio). Feb. 19, 1969. Contract AT(26-1)-171. 67p. Dep. CFSTI.

Battelle Memorial Institute, Columbus Laboratories, with assistance from scientists in several universities and the U. S. Bureau of Commercial Fisheries, is responsible for bioenvironmental safety studies at Amchitka Island, Alaska, where the U. S. Atomic Energy Commission, Nevada Operations Office, may conduct a series of underground nuclear tests. The bioenvironmental studies are designed to predict, evaluate, and document the effects on the biota and environment if the tests are carried out, to recommend measures for minimizing the effects, and to predict and evaluate the potential hazards to man if there is an accidental release of radionuclides. This report covers the research conducted during the first fiscal year of the program in the fields of ecology, physiological response of aquatic animals to water overpressure pulses, chemical and radiochemical analyses, source-term prediction and shock-wave correlations, and mathematical simulation. The bioenvironmental safety studies are directed specifically to the fishes (e.g., salmon species, halibut, and Pacific Ocean perch), shellfishes (e.g., shrimp and crab species), marine mammals (e.g., sea otter), and birds (e.g., bald eagle, winter wren, emperor goose, and duck species) that are important to man, and to the food chains and environments of these species. Although the studies were not completed during FY 1968, they contributed much to our knowledge of the marine, freshwater, and terrestrial ecosystems at Amchitka. Since we have not documented the ecological effects of a large underground nuclear test at Amchitka Island, it is not feasible to predict magnitudes of the changes that may result if such tests are made. However, our studies have progressed to the point that we can predict the types of changes that can be expected and, in some cases, we can recommend measures for mitigating the undesirable changes. (auth)

26710 (BMI-171-117) PRIMARY PRODUCTIVITY AND LIMITING FACTORS IN FOUR FRESHWATER PONDS ON AMCHITKA ISLAND, ALASKA. Amchitka Bioenvironmental Program. Gordon, Kenneth R. (Ohio State Univ., Columbus)., Jan. 31, 1969. Contract AT(26-1)-171. 41p. Dep. CFSTI. For Battelle Memorial Inst., Columbus, Ohio.

The objectives of this study were to determine primary productivity rates in four selected ponds on Amchitka Island, Alaska; to determine which nutrients might be limiting primary productivity; and to investigate the possible effects of seismic disturbances on rates of primary productivity. Water samples were collected, various nutrient solutions were added, and the samples were incubated in situ from 1 to 2 days. Primary productivity was then estimated by the use of the ^{14}C method of Steemann Nielsen. Results indicated that the primary-productivity rates of the four ponds approximate rates reported for other arctic lakes by other researchers. Phosphate appeared to be limiting to primary productivity in Ponds 3 and 4. The trace-element solution used inhibited carbon fixation in all four ponds. It was hypothesized that vitamins, phosphate, and nitrate may be stimulatory to carbon fixation by a small population of the entire plankton community in Ponds 1 and 2. Sediment extract was stimulatory to primary productivity in Ponds 2 and 4 and inhibitory in Pond 3. It was concluded that a seismic event mixing sediment with the pond water will have diverse effects on different pond types. Primary productivity will increase in some ponds and decrease in other ponds as a result of a seismic event. (auth)

26711 (SWRHL-52) RANGE SURVEY, AREA 18, NEVADA TEST SITE. Brown, Kenneth W.; Mason, Benjamin J. (Public Health Service, Las Vegas, Nev. Southwestern Radiological Health Lab.). Dec. 1968. 42p. Dep. CFSTI.

The ocular reconnaissance method of surveying vegetation was used to survey 13,630 acres in Area 18 Nevada Test Site. A total of 233 line transects were established to obtain species distribution, composition, and ground cover. There were six distinct plant communities identified: two sagebrush (Artemisia arbuscula subsp. nova, A. tridentata), two annual (Salsola kali var. tenuifolia, Eriogonum), one grass, and one Desert Shrub. These six communities contained a total of 36 families and 85 species. The A. arbuscula subsp. nova community occupied the largest area, 6,337 acres, and the Eriogonum community the smallest, 17 acres. (auth)

26712 (UCLA-12-706, pp 73-90) ENVIRONMENTAL RADIATION. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology).

Thermoluminescence of nine soils that were widely different in chemical and physical characteristics was examined. Soils irradiated with up to 1,000 R of ^{60}Co gamma rays showed a wide range of thermoluminescence. Determinations of ^{90}Sr and calcium concentrations in mandibles and teeth of mule deer in California were made. Variation in ^{90}Sr concentration was associated with latitude, year of collection, age of the animal, and rainfall of the location of collection. Dispersal of two species of kangaroo rats and two species of pocket mice in the Mojave Desert was examined. Effects of continuous low-level exposure to γ radiation on a population of small mammals (Peromyscus maniculatus sonoriensis) were studied. The intrinsic rate of natural increase was increased in animals irradiated as adults as a result of an elevation of the instantaneous rate of birth and a reduction of the instantaneous death rate. Studies on natural populations of the leopard lizard (Crotaphytus wislizeni) included biomass determinations and modal pattern of reproduction. Ecosystem studies were conducted at 68 permanent study sites at the Nevada Test Site. A post-reproduction census of the rodents on each site was conducted for the fifth consecutive year during July and August. Quantitative data for the summer annual plants were obtained for the sixth consecutive year in September. Computer programs for compilations of the environmental data were written and executed. Plant experiments with ^{18}F showed that the isotope was readily taken up by roots from nutrient media and translocated through alfalfa, bean, and tomato plants where it concentrated more in leaf than in stem tissues. Samples of plants, milk, water, feces, and air filters were analyzed for ^{144}Ce, ^{137}Cs, and ^{90}Sr using the gamma detector system. A method for rapid separation of radiomanganese by liquid-liquid extraction was developed. Studies were conducted on retranslocation of ^{137}Cs, K, and ^{86}Rb to new leaf growth in bush beans. Studies on transport of ^{45}Ca, ^{137}Cs, ^{42}K, and ^{85}Sr in barley and bush bean plants were conducted. The role of calcium as a micronutrient and its relationship to other micronutrients was studied. The effect of monovalent ion carriers on the transport of ^{137}Cs and ^{86}Rb into bush bean plants was investigated. Studies on nitrogen cycling in soils and crops at the Nevada Test Site were conducted. Studies were conducted on responses of desert shrubs from the northern Mojave Desert to moisture and temperature. (H.L.W.)

26713 ABOUT SOME METHODS WHICH MAY BE USED IN INVESTIGATING THE DYNAMICS OF ACCUMULATION OF RADIOACTIVE ISOTOPES IN A FRESH WATER EKO-SYSTEM. Matulyavichene, N. I.; Matulyavichyus, V. P.; Styro, B. I. (Inst. of Botany, Vilnyus, USSR. Inst. of Physics and Mathematics, Vilnyus, USSR). Liet. TSR Mokslu Akad. Darbai, Ser. B, No. 3, 187-91(1968). (In Russian).

Radioactivity registering on the detector is placed into the investigatory environment, e.g., into soil. The level of radioactivity is constantly registered by apparatus. The investigation with different detectors showed that using direct detective methods it was possible to register accurately the increment of radioactive concentration. The increment of radioactive concentration in investigatory environment is only weakly registered as it is practically impossible to escape the absorption of radioactive substances into the defensive cover of the detector. (auth)

26714 PECULIARITIES OF THE WATER BASIN MODEL USED IN INVESTIGATING THE ACCUMULATION OF RADIOACTIVE SUBSTANCES WITH THE HELP OF EKO-SYSTEM COMPONENTS. Matulyavichene, N. I.; Matulyavichyus, V. P. (Inst. of Botany, Vilnyus, USSR. Inst. of Physics and Mathematics, Vilnyus, USSR). Liet. TSR Mokslu Akad. Darbai, Ser. B, No. 3, 193-8(1969). (In Russian).

A small scale modeling of an artificial basin used in investigating the sorbic peculiarities of organic and inorganic sorption while accumulating radioactive substances was analyzed. It is evident that the water basin model will render good indices if in a series of samples a normal development of organic sorption takes place and if the coefficient of accumulation is determined with minimum costs of experiment. (auth)

26715 VOPROSY BIOOKEANOGRAFII. MATERIALY II MEZHDUNARODNOGO OKEANOGRAFICHESKOGO KONGRESSA, 30 MAYA-9 IYUNYA 1966 G, MOSKVA. (Problems in Bio-oceanography. Reports of the Second International Oceanographic Congress, May 30–June 9, 1966, Moscow). Kiev, Izdatel'stvo Naukova Dumka, 1967. 228p. (CONF-660574).

The volume represents a collection of 31 papers presented at the Second International Oceanographic Congress in Moscow. Separate abstracts were prepared for six papers of interest. In addition to articles on radioecological problems, abstracted separately, the subjects covered include circulation of water in stratified straights (Bosporus and Bab-el-Mandel), economic utilization of shoals, the oceanographic aspects of sewage disposal in the littoral waters of the Black Sea, determination of microelements in the Black Sea, biochemical aspects of the study of sea plankton, production of phytoplankton in the Red Sea, the role of the substratum in the settling of the Bryozoa larvae, the energy balance of planktons from various ecosystems of the Black Sea, the transformation of energy of Artemia salina (L), the seasonal dynamics of photosynthetic pigments of some Black-Sea algae, comparative data on the development of the benthos in the seas of the Mediterranean basin, and the effect of petroleum products on the development of sea plankton, etc. (TTT)

For abstracts of individual papers see: 26362, 26670, 26716, 26774, 26776, and 26891.

26716 MARINE RADIOECOLOGY AND OCEANOGRAPHY. Polikarpov, G. G. pp 169-79 of Voprosy Biookeanografii. Materialy II Mezhdunarodnogo Okeanograficheskogo Kongressa, 30 Maya-9 Iyunya 1966 g, Moskva. Kiev, Izdatel'stvo Naukova Dumka, 1967. (In Russian).

From 2nd International Oceanographic Congress, Moscow, USSR. See CONF-660574.

Marine radioecology involves the study of the role of marine life in the distribution, migration, and circulation of natural and artificial radioactive materials in the world's seas and oceans. The absorption and accumulation of radioactive materials in marine organisms may be viewed as a physical phenomenon, considering primarily the physico-chemical properties of living structures and the processes occurring in them, devoting special attention to phenomena involved in the passage of material from the external or internal medium. This approach considers, for example, the behavior of potassium, sodium, calcium, and other elements, ions, and complexes. The radioecological approach takes into account all of the radioelements and radionuclides that interact in living organisms and result in the accumulation of these elements in simple or isolated biological systems. The processes considered include isotopic exchange with the solution, surface adsorption, and the feeding chain. On the basis of experimental data and theoretical studies, laws were derived concerning the concentration of chemical elements in the hydrobiont at various concentration levels. Mathematical formulas were developed to clarify the accumulation of artificial radioactive elements, ^{90}Sr and ^{137}Cs in oceans and in fresh waters. Thus, marine radioecology attempts to establish universally valid laws; it is one of the most important areas of international cooperation. (TTT)

Genetics and Cytogenetics

Refer also to abstracts 26966 and 28659.

26717 (BNL-13430) ROLE OF SOMATIC MUTATIONS IN CARCINOGENESIS. Curtis, H. J. (Brookhaven National Lab., Upton, N. Y.). [1968]. 18p. (CONF-690404-2; SM-118/10). Dep. CFSTI.

From Symposium on Radiation-induced Carcinogenesis, Athens, Greece.

The evidence now seems quite clear that some form of multiple step induction process is required to explain carcinogenesis. The long delay between an event which initiates a cancer and its final induction is hard to explain any other way. In addition, many experiments with radiation and chemicals demand such a scheme. A mutation must be one of the early steps, and a stimulus for cell division must follow. The nature of the other steps is not clear but available evidence indicates that later steps probably do not involve a mutation. The number of steps postulated in the induction process could be reduced considerably if the mutation rate increased with age, but good evidence indicates that such is not the case. Finally, it might be supposed that a cancerous mutation would be repaired if it did not have an opportunity to express itself in a reasonable time after initiation, but available evidence indicates that such a mutation is rarely if ever repaired. (auth)

26718 (NYO-2733-16) COMPARATIVE ANALYSIS OF THE BEHAVIOR OF NATURAL AND OF RADIATION INDUCED LETHALS IN NATURAL AND IN LABORATORY POPULATIONS. Final Report. (Sao Paulo Univ. (Brazil)). Dec. 1967. Contract AT(30-1)-2733. 23p. Dep. CFSTI.

Summaries of publications that evolved from comparative analysis of the behavior of natural and radioinduced lethals in wild and laboratory populations of Drosophila willistoni are presented and discussed briefly. (C.O.)

26719 RESTRICTED REJOINING OF CHROMOSOMAL SUBUNITS IN ABERRATION FORMATION: A TEST FOR SUBUNIT DISSIMILARITY. Brewen, J. G.; Peacock, W. J. (Oak Ridge National Lab., Tenn.). Proc. Nat. Acad. Sci. U. S., 62: 389-94 (Feb. 15, 1969).

The chromosomal subunits that segregate from each other during chromosome replication are shown to be uniquely different. An analysis of tritiated thymidine labeled chromosomal subunits in dicentric chromosomes, generated by isolocus breakage followed by proximal reunion, shows that the end-to-end association of the subunits is not random but is strictly preferential. The data suggest that the functional subunit in the formation of these particular chromosomal aberrations might be single polynucleotide chains of deoxyribonucleic acid, although other molecular species cannot be disregarded. The suggestion that the DNA is the molecule that is involved is based on the fact that the two chains of the DNA double helix exhibit reverse polarity and this property predicts the observed autoradiographic patterns. (auth)

26720 OVERALL PROBLEM OF THE RADIATION BREEDING OF PLANTS. Muszynski, Stanislaw. Postepy Nauk Roln., 15: No. 2, 71-80(Mar.-Apr. 1969). (In Polish).

Radiation breeding became an accepted scientific technique. Certain effects that could be obtained only with difficulty by other methods, may be achieved quickly and conveniently by this technique. The effect of radiation on plants was first studied in Sweden in 1954; since then many investigations have been carried out on mutation effects in several countries. The areas in which the method has been applied widely include: macromutation, micro-mutation, biochemical mutation, chromosome aberration, structural changes in tissues, stimulation, and cross breeding. (Review article, 31 references.) (TTT)

26721 RELATION BETWEEN HOMOZYGOUS VIABILITY AND AVERAGE DOMINANCE IN DROSOPHILA MELANOGASTER. Morton, N. E.; Chung, C. S.; Friedman, L. D. (Univ. of Wisconsin, Madison). Contract AT(11-1)-827. Genetics, 60: 601-14 (Nov. 1968).

Chromosomes supervital or subvital in homozygotes tend to have the same effects in heterozygotes, and the degree of dominance (h) approaches ½ as the homozygous effect (s) approaches zero. Dominance decreases at high levels of inbreeding. There is no evidence for overdominance. Data are inconsistent with Kimura's principle of minimum genetic load. (auth)

26722 WAXY LOCUS IN MAIZE. II. THE LOCATION OF THE CONTROLLING ELEMENT ALLELES. Nelson, Oliver E. (Purdue Univ., Lafayette, Ind.). Genetics, 60: 507-24(Nov. 1968).

A revised map of the wx locus locating 24 alleles approximately is based on pollen and conventional genetical analyses. Three controlling element alleles, m-1 and m-6 of the Ac-Ds system and m-8 of the Spm system, recombine with each other and with most other wx alleles. There are stable wx alleles located both distally and proximally to the controlling element alleles.— Recombination frequencies across the locus are not additive, but map construction is possible using overlapping mutations plus the data from conventional analyses.— Many alleles cannot be represented as points on the genetic maps since they do not recombine with two or more alleles that recombine. Two alleles, B7 and C34, do not recombine with any of the other wx alleles with which they were tested. (auth)

26723 FINE STRUCTURE MAPPING OF THE TRYPTOPHAN GENES IN PSEUDOMONAS PUTIDA. Gunsalus, I. C.; Gunsalus, C. F.; Chakrabarty, A. M.; Sikes, S.; Crawford, I. P. (Univ. of Illinois, Urbana. Scripps Clinic and Research Foundation, La Jolla, Calif.). Contract AT(11-1)-1683. Genetics, 60: 419-35 (Nov. 1968).

The chromosomal organization of Pseudomonas putida was investigated using transducing phage pf16 in experiments involving both cotransfer of specific markers and depression of prototrophic frequency. Six genes affecting tryptophan synthetic enzymes were mapped in three linkage groups; these correspond to the regulatory groups established earlier by biochemical studies. The genes in the first group, trpABD, specifying AS, PRT, and InGPS, were shown to occur in that order, with contiguity between trpB and D but a short distance separating the trpA and B markers. Loci for p-fluorophenylalanine and streptomycin resistance are linked to the trpABD cluster. The fpa cistron lies on the trpA side with about 50% cotransfer; str lies on the trpD side with about 20% cotransfer. A second linkage group contained the gene for PRAI, trpC, surrounded by met, ade, and leu loci. The third linkage group contained the loci trpE and F for the A and B subunits of tryptophan synthase; these are closely linked, and a locus conferring constitutivity upon them also maps very near. A considerable similarity exists in chromosomal organization between P. putida and P. aeruginosa. (auth)

26724 ISOLATION AND SOME PROPERTIES OF THE RADIATION-SENSITIVE MUTANT OF S. TYPHIMURIUM LT 2. Skavronskaya, A. G.; Pokrovskii, V. N.; Zlatev, V. I.; Andreeva, I. V. (Gamaleya Inst. for Epidemiology and Microbiology, Moscow). Mutat. Res., 7: 248-51(Mar.-Apr. 1969).

A uv-radiosensitive mutant (P5) was isolated from cultures of Salmonella typhimurium LT2 following treatment with methylnitrosoguanidine (NG). In addition to its uv-radiosensitivity, which was independent of incubation temperature, the cells had decreased host-cell reactivation ability, increased sensitivity to crystal violet and NG, and a spontaneous mutation rate ($Ile^- - Ile^-$) of 1.5 × 10^{-7}. Its sensivitity to γ radiation was similar to that of the LT2 strain. The P5 mutation is being mapped more precisely. (E.R.B.)

26725 STUDIES ON THE INDUCTION OF TRANSLOCATIONS IN MOUSE SPERMATOGONIA. II. EFFECTS OF FAST NEUTRON IRRADIATION. Searle, A. G.; Evans, E. P.; West, B. J. (Medical Research Council, Harwell, Eng.). Mutat. Res., 7: 235-40(Mar.-Apr. 1969).

The rate of induction of reciprocal translocations by fast neutron irradiation of mouse spermatogonia was studied by cytological examination of descendant spermatocytes. With acute irradiation (49 to 55 Rad/min) the frequency of affected spermatocytes rose to a maximum of 8.7% at 100 Rad, falling abruptly at higher doses to 1.6% at 220 Rad. With chronic irradiation over 12 weeks, however, no such fall-off was found. Instead, the yield at 214 Rad neutrons was 21.7%, while that at 62 Rad was 3.3%, which is significantly less than expected on a linear hypothesis. If one assumes linearity at low doses, the neutron-X RBE for acute irradiation is about 4 and the neutron-γ RBE for chronic irradiation is about 20 to 25. (auth)

26726 MODIFICATION OF X-RAY-INDUCED CHROMOSOME CHANGES WITH ANOXIA IN DIFFERENT OOCYTE STAGES OF DROSOPHILA MELANOGASTER. Seeley, Barbara A.; Abrahamson, Seymour (Univ. of Wisconsin, Madison). Mutat. Res., 7: 225-30(Mar.-Apr. 1969).

The effect of postirradiation treatment with anoxia on the detachment of attached-X chromosomes induced by x rays in stage-7 and stage-14 oocytes was studied. Anoxia produced a highly significant increase ($P < 0.0001$) in the detachment frequency in the nitrogen posttreated group as compared to the group given no post-treatment in stage-7 oocytes. The results of 12 experiments on stage-14 oocytes indicate that anoxic posttreatments produce a significant increase ($P = 0.005$) in the frequency of detachments. Thus anoxia has an effect on both stage-7 and stage-14 oocytes. It is suggested that anoxia keeps breaks open longer than air and also allows for enhanced movement of broken chromosome ends that leads to an increase in the rearrangement frequency. It is expected that this mechanism would be more effective in stage-7 cells, where any delay in rejoining and added movement will greatly increase the chance for rearrangement where normally a short time exists for chromosome movement prior to rejoining. Stage-14 oocytes, where broken chromosomes remain unrestituted until after fertilization and thus have a chance for normal chromosome movement over a period of time, would not be expected to show as great a response to additional movement. (auth)

26727 MITOTIC RECOMBINATION AND MUTATION. Volterra, Laura; Morpurgo, Giorgio (Istituto Superiore di Sanita, Rome). Mutat. Res., 7: 155-62(Mar.-Apr. 1969).

It was shown that intragenic mitotic recombinants in the pfp gene in Aspergillus nidulans were derived both by a reciprocal and a non-reciprocal process. Reciprocal recombination usually modifies the genes in both the strands involved; on the other hand non-reciprocal recombination does not modify the gene. (auth)

26728 CYTOPLASMIC AND NUCLEAR GENETIC EVENTS INDUCED BY UV LIGHT IN STRAINS OF SACCHAROMYCES CEREVISIAE WITH DIFFERENT UV SENSITIVITIES. Moustacchi, E. (Inst. for Radium-Biology, Orsay, France). Mutat. Res., 7: 171-85(Mar.-Apr. 1969).

The lethal effect, the induction of nuclear gene back mutations in haploids (hiI, adI, and leu2), of mitotic recombination in diploids and the induction of the cytoplasmic petite mutation by uv light were compared in the wild type and in the uv-sensitive mutant (uvs_2) of Saccharomyces cerevisiae. The following results were obtained: The uv induction of mutations as a function of dose was higher in the uvs_2 strain than in the wild type for the loci examined. The frequency of mitotic recombinants induced by uv light was greater among survivors in the homozygotes uvs_2/uvs_2 than in the heterozygotes $uvs_2/+$ controls as a function of dose. In contrast, the frequency of uv-induced cytoplasmic petite mutation was not significantly increased for the uvs_2 strain in the range of dose used (10^{-6} survivors). If the cytoplasmic factor is equated with the mitochondrial DNA, these results may suggest that the fraction of the mitochondrial population, genetically active, is not susceptible to the repair system that is operative for the nuclear events studied. (auth)

26729 MUTAGEN SPECIFICITY AT THE ad-3A AND INOSITOL LOCI IN NEUROSPORA CRASSA. Allison, M. (Inst. of Animal Genetics, Edinburgh). Mutat. Res., 7: 141-54(Mar.-Apr. 1969).

Four adenine-3A alleles in Neurospora crassa in diauxotrophic combination with three inositol alleles were tested for their mutational responses to uv radiation, ethyl methanesulphonate, and diepoxybutane. Although in every case the responses of different alleles to a given mutagen overlapped in part of their range, there were marked differences between the mean and maximal responses of alleles, especially after chemical treatment. The pattern of allele specificity is too complex for an interpretation solely on the basis of the initial DNA damage. It appears that specificities arising at some later stage in mutagenesis contribute to the observed response pattern. (auth)

26730 INDUCED MUTATIONS AND PLANT BREEDING METHODS IN VEGETATIVELY PROPAGATED SPECIES. Hazama, Kazuo. Nippon Sanshigaku Zasshi, 36: 346-52(1967).

Radiation and chemicals were used to induce mutations. But to induce bud mutations in vegetatively propagated species, radiation was more effective than the utilization of chemicals. For the induction of bud mutations, winter buds or terminal buds were generally irradiated, and since these buds had a high water content compared with the seeds, they were more susceptible to the radiation. Needle-leaf trees are more susceptible to the radiation than broad-leaved trees; the growth of the former was considerably inhibited even at a dose rate of 10 R per day. In the occurrence of deformed leaves of tea-plants, differences among its species were clearly observed. Mulberry trees were in general resistant to the radiation. Most important in selection of a bud mutation was the finding of a method for effectively isolating mutated parts from the chimeric shoots occurring in the irradiated plants. Mulberry saplings were irradiated with γ rays, and were subjected to cutting-back and grafting each year. The result was the reduced occurrence of chimeric shoots and the increased occurrence of completely mutated shoots. (NSA of Japan)

26731 STUDIES WITH ^{60}Co RADIATED GUAR (CYAMOPSIS TETRAGONOLOBA (L.) TAUB. **Vig, Baldev K. (Univ. of Nevada, Reno). Ohio J. Sci., 69: 18-31(Jan. 1969).**

Studies were carried out on the effect of radiation on this forage legume with a view to determining the mutants of economic or academic interest. Dry seeds of G-II (bushy, fodder type) and G-IV (erect, pod type) varieties of Punjab guar were γ-irradiated using ^{60}Co with doses of 5,000, 10,000, 20,000, and 30,000 R. Irradiation accelerated germination, increased the rate of root growth, and expanded the range of plant height and stem girth in the generation from the irradiated seeds (R_1). Other morphological variants in R_1 were: chlorophyll defects, small-leaved and small-podded types, unusually tall and unusually small plants, and chimeras for pod and leaf size. In R_2 none of the above characters excepting chlorophyll defects appeared, thus establishing that nongenetic changes were responsible for other variations. In R_2 and R_3, however, segregation was observed for plant height and branching from both G-II and G-IV. In no case were the number of genes involved determined. (BBB)

26732 GENETIC CHANGES CAUSED BY CHEMICALS. 2. RECIPROCAL MITOTIC RECOMBINATION. **Schwaier, Roland (Univ., Freiburg i. B.). Ber. Deut. Bot. Ges., 80: 487-91 (Dec. 30, 1967). (In German).**

Some effects of x irradiation and uv light in producing genetic recombinations are discussed briefly. Mitotic recombinations can be induced by x rays or uv light, although normally they occur spontaneously relatively infrequently. Following irradiation with 40 KR of 50 kV x ray, the recombination frequency induced was about 1% for ad_2-hi_8 homozygotes of *Saccharomyces cerevisiae.* The survival rate was 59%. This strain has a respiratory defect that makes it incapable of meiosis, but the frequency of recombination was similar to that of normal yeast. Recombinant colonies that were induced by x rays were found to contain 50% clones that were actidion sensitive. Irradiation of cultures of Ustilago with uv light may also delay DNA replication by inducing dimer formation, deamination, or alkylation. (BBB)

26733 RADIOINDUCED MUTATIONS IN DERMATOPHYTES. III. STUDIES ON THE RELATION BETWEEN THE VIRULENCE AND MICROMORPHOLOGY AND KERATINOLYTIC ACTIVITY. **Hejtmanek, M.; Hejtmankova-Uhrova, Nora; Lenhart, K.; Kunert, J.; Vicikova, Libuse (Palacky Univ., Olomouc, Czech.). Mycopathol. Mycol. Appl., 34: 123-8(Feb. 28, 1968). (In German).**

The following eight types of mutants were selected after uv-radioinduced mutation of a morphologically normal strain of *Microsporon gypseum:* strains with production of macroconidia, microconidia, and chlamydospores; strains with macroconidia and microconidia; strains with macroconidia and chlamydospores; strains with microconidia and chlamydospores; strains with macroconidia only; strains with microconidia only; strains with chlamydospores only; and mycelial strains without production of spores. All the strains of the eight groups were keratinolytically active in vitro and sensitive to griseofulvin. Only quantitative differences, in the features evaluated, were found. Some mutants were more than 10 times more sensitive to griseofulvin in comparison with the wild strains. Avirulent strains were isolated from the virulent wild strain *M. gypseum.* The strains producing only chlamydospores and mycelial strains without sporulation were avirulent in all cases. The greater part of conidia-producing strains remained virulent. No relation between the degree of keratinolytic activity in vitro and virulence in vivo was found. Virulence itself cannot be determined by an increase in keratinolytic activity in vitro, alone. (BBB)

26734 CLONAL ANALYSIS OF DETERMINATION DYNAMICS IN CULTURES OF IMAGINAL DISKS IN DROSOPHILA MELANOGASTER. **Gehring, W. (Univ., Zurich). Develop. Biol., 16: 438-56(Nov. 1967).**

Single cells were marked genetically by x-radioinduced somatic crossing over or somatic mutation in antennal disks of Drosophila larvae. The irradiated disks were cultured in adult female hosts, where the marked cell gives rise to a clone. After retransplantation into a larval host the differentiation of such clones was analyzed. It was shown that changes in determination (transdetermination) can occur in such cell clones. Thus, presumptive palp cells that normally produce their own type of cells by cell heredity, may give rise to wing cells (allotypic elements). Presumptive cells of the arista and the third antennal segment may produce tarsal cells, whereas the anlage of the second segment rarely forms any allotypic elements. Each transdetermination from one cell type to another occurs with a definite probability. During proliferation a group of cells may undergo the same type of transdetermination synchronously. (BBB)

26735 EFFECTS OF IRRADIATION UPON STARCH FORMATION AND STARCH HYDROLYSIS IN TOMATO MICROSPORES. de Nettancourt, Dreux; Eriksson, Goesta (EURATOM-ITAL, Wageningen, Netherlands). Hereditas, 60: 167-76(1968).

Most of the differences observed in the radiation responses of closely related genotypes of tomatoes can be explained on the basis of variations in growth rate and in numbers of apical cells at the time of irradiation. To estimate sensitivities in terms of specific criteria that are not directly dependent upon growth rate of cell numbers in the apex, attempts were made to detect and to use pollen markers for evaluating the effects of irradiation upon pollen mother cells and developing microspores. In *Lycopersicum esculentum* an analysis was made of the effects of x irradiation upon starch formation and starch hydrolysis in tomato microspores. Bud irradiation tended to inhibit starch hydrolysis in the microspores. For this criterion the period of greater sensitivity was observed to take place shortly prior to pollen mitosis and before the beginning of starch formation. Among 806 M_1 plants that were irradiated at the seed stage, the pollen grains from one individual were found to segregate in a 1 to 1.3 ratio for presence of starch in the open flower. Starchy pollen grains are sterile but it is hoped that the mutation can be transmitted by the female germplasm and will be recovered in the next generation. Scoring tests were also conducted on buds that were irradiated at the meiotic stage and harvested one day after the initiation of starch synthesis. The results obtained demonstrated that it is possible to induce tomato pollen mutants that resemble the waxy pollen grains in maize and barley. (BBB)

26736 A SURVEY OF TRANSLOCATION STUDIES IN VICIA FABA L. **Sjoedin, Jan; Hagberg, Arne (Swedish Seed Association, Svaloef). Hereditas, 59: 242-52(1968).**

Mutagenic effects of x rays, neutrons, and γ rays and some chemical agents in the Svaleof Primus variety of the bean were determined. For the chemical treatments ethyleneimine, ethylmethanesulfonate, 8-ethoxy-caffeine, and methylmethanesulfonate were used. The critical dose, LD_{50}, and absolute lethal dose were determined for all of these physical and chemical agents. The critical dose was defined as the dose which induces a maximum of mutations and chromosome rearrangements but still produces a sufficiently large field material. Reciprocal translocations were isolated after mutagenic treatments and were identified by the aid of a tester set and by measurements of the length of the chromosomes with respect to involved chromosomes and approximate breakage points. It was shown that x rays and neutrons give significantly higher aberration frequencies than chemical mutagens. It was also shown that the distribution of aberrations is not at random. The long chromosome 1 is involved in a significantly lower number of translocation aberrations than the 5 short chromosomes. The ratio obtained for long/short chromosomes was 1 : 3.47 compared with the expected ratio 1 : 2.50. There was also an unequal distribution of breakage points on the short chromosomes. (BBB)

26737 BODY WEIGHTS AND EMBRYONIC MORTALITY IN AN IRRADIATED POPULATION OF MICE. Green, Earl L. (Jackson Lab., Bar Harbor, Me.). Mutat. Res., 6: 437-48(Nov.-Dec. 1968).

Nonirradiated progeny of irradiated and nonirradiated sublines of an experimental population of mice were intermated, brother × sister, to try to detect the effects, if any, of the accumulated genetic exposure of the parents to x irradiation on the 60-day body weights, the embryonic mortality rates, and the fetal abnormality rates among their offspring. The sublines differed by having accumulated genetic exposures from 0 to 4494 R after 14 generations and from 0 to 4847 R of x rays after 15 generations. The mean body weight of the male offspring declined at a rate of about 6.75 g and of the female offspring at about 2.00 g per 10,000 R of accumulated genetic exposure of the parents, but there was no apparent effect upon the embryonic mortality rate nor upon the fetal abnormality rate. The occurrence of a larger decline in body weight in males suggests that the decline is due to X-linked mutations having deleterious effects in the hemizygous sex. (auth)

26738 NON-RANDOM DISTRIBUTION OF X-RAY-INDUCED ACHROMATIC LESIONS ("GAPS") IN THE CHROMOSOMES OF VICIA FABA. Scheid, W.; Traut, H. (Univ., Muenster, Ger.). Mutat. Res., 6: 481-3(Nov.-Dec. 1968).

Non-staining bands called gaps are the most frequent microscopically visible effect of x radiation on chromosomes of the broad bean *Vicia faba.* Their frequency was found to increase linearly with dose and to depend to a great extent on the cell stage irradiated. Results are reported from a statistical analysis of the distribution of gaps in five acrocentric S chromosomes of Vicia seedlings scored at metaphase. The departure of the observed distribution of gaps from a random distribution was considered highly significant. (C.H.)

26739 RESISTANCE TO USTILAGO NUDA OF SOME TYPES OF WINTER BARLEY OBTAINED BY SEED IRRADIATION. Grinvald, Clara. An. Inst. Cercet. Pentru. Cereale Plante Teh.-Fundulea, Ser. C, 34: 141-7(1967). (In Rumanian).

Between 1964 and 1966 some mutants obtained by irradiating two populations of winter barley with thermal neutrons were analyzed as compared to the Cenad 345, Cenad 396 recommended varieties and to some promising lines developed by the Plant Breeding Section of the Research Institute for Cereals and Technical Plants, as to their resistance to attacks by *Ustilago nuda*. The material was tested both under naturally and artificially-induced infection conditions. The material was tested by artificial infections both under common cropping and irrigation conditions. The results show that types 11/63 and 100/63 have a good resistance to smut attacks, these being far better than the other types, the recommended varieties, and the non-irradiated promising lines. A medium to satisfactory resistance was found in types 7/63 and 24/63, that similarly were superior to the recommended varieties and promising lines investigated. From these experiments it was found that type resistance to *Ustilago nuda* is determined by the genotype of the new forms and is not a consequence of some functional causes. (auth)

26740 FREQUENCY OF X-RADIOINDUCED RECESSIVE VISIBLE MUTATIONS IN THE RAT. Taylor, B. A. (Univ. of Wisconsin, Madison). Contract AT(11-1)-697. Genetics, 60: 559-65 (Nov. 1968).

During an experiment on the genetic effects of cumulative spermatogonial irradiation in rats, six recessive visible mutations were detected in the irradiated lines as compared to three in the control line. Frequencies were estimated to be 0.8×10^{-3}/generation/gamete and 1.6×10^{-5}/gamete/R for spontaneous and induced mutations, respectively. These results are compared with similar studies in mice. (auth)

26741 INVESTIGATIONS ON THE OIL CONTENT AND SATURATION VALUE OF THE OIL OF FLAX MUTANTS AND THEIR CORRELATION WITH SOME OTHER PLANT CHARACTERS. Rath, L.; Scharf, H. (Martin Luther Univ., Halle-Wittenberg, Ger.). Theor. Appl. Genet., 38: 280-8(Oct. 21, 1968). (In German).

An analysis of the oil content and refractive index (as a measure of the saturation value of the oil) was carried out from 1961 to 1964 on a collection of about 700 flax mutants derived by x irradiation from the two stocks no. 6 and no. 36. The radiation doses varied from 10 to 60 R, as given to the air-dried seeds. The average refractive index of the oil was highest under the cool and rainy conditions of 1961, lowest in the warm and dry year 1963. The maximum differences in the mean refractive index of the collections between 1961 and 1963 amounted to an iodine number of six (mutants of stock no. 6) or five (mutants of stock no. 36). The variability of both characters was significantly increased in the two radioinduced mutant stocks. The average oil content showed, on the other hand, a decrease of about 1%. The degree of unsaturation of the oil was higher in the radioinduced mutants derived from no. 6, and lower in those derived from no. 36 when compared with the untreated material. No correlation (no. 36) or a negative correlation (no. 6) was found for the characters of oil content and refractive index. Subgrouping of such characters as plant height, seed coat color, and flower color, led to considerable differences in oil content and refractive index. Mutants with yellow seed coat color were always characterized by a high oil content and a high refractive index. (BBB)

26742 SPLIT-DOSE EXPERIMENTS WITH STAGE-14 OOCYTES OF DROSOPHILA MELANOGASTER. Wuergler, F. E.; Matter, B. E. (Swiss Federal Inst. of Tech., Zurich). Mutat. Res., 6: 484-6(Nov.-Dec. 1968).

Virgin female *Drosophila melanogaster* were exposed to 600 R x radiation delivered as a single dose or as two dose fractions of 300 R each. The females were mated with normal males and early, late, and total embryonic mortality was determined for Stage-14 oocytes. A slight decrease in the mortality rate was observed following dose fractionation. The results indicated that chromosomes of Stage-14 oocytes are capable of repairing some of the radioinduced damage. However, only about 10% of the initial damage was repaired within 8 hr. (C.H.)

26743 TESTS FOR POISSON DISTRIBUTIONS OF TRANSLOCATIONS BETWEEN SPERMATOCYTES. Papworth, D. G. (Medical Research Council, Harwell, Eng.). Mutat. Res., 6: 434-6(Nov.-Dec. 1968).

The distributions of chromosome translocations between spermatocytes found in each testis of the 36 irradiated mice were analyzed separately by statistical methods using computer calculations. The significance levels associated with the five chosen statistics were generally in close agreement, indicating that the tests are satisfactorily consistent. Of the 72 distributions tested, 17 (or nearly 24%) showed a significant deviation from a Poisson distribution at the 5% level or higher. The results indicated that the induction of translocations in spermatogonia is non-random, at least when the rate of induction is high. Distributions like these, that deviate from a Poisson distribution in the direction of overdispersion, can often be fitted satisfactorily by a negative binomial distribution that in this context could be interpreted as a variation from spermatogonium to spermatogonium in the degree of susceptibility to translocation. (C.H.)

26744 SEED COLOR MUTATION IN BRASSICA JUNCEA HOOK. f. AND THOMS. INDUCED BY RADIOACTIVE PHOSPHORUS: ^{32}P. Nayar, G. G. (Bhabha Atomic Research Centre, Bombay). Sci. Cult. (Calcutta), 34: 421-2(Oct. 1968).

Seeds of *Brassica juncea* var. Rai 5 were treated with 8.70 μCi, 13.05 μCi, and 21.75 μCi of ^{32}P per seed for 24, 48, and 72 hr duration. One hundred seeds were treated for each dose; seeds soaked in distilled water served as controls. Among the population derived from the 21.75 μCi/72 hr treatment, three selections had yellow seeds. These bred true during subsequent generations and were designated as yellow seed mutant, γSM_3. The morphological characters of the leaves of γSM_3 are described and compared to those of yellow-seeded varieties of *B. campestris* L. (C.O.)

26745 CYTOLOGICAL IDENTIFICATION OF TRANSLOCATION IN BARLEY (HORDEUM SATIVUM JESS, VAR. VALTICKY). Gacek, E. (Inst. of Plant Breeding and Acclimatization, Krakow). Genet. Pol., 8: 193-7(Dec. 1967).

Cytological analyses for detection of translocation in ^{60}Co γ-irradiated plant material of *Hordeum sativum* Jess, var. Valticky were carried out. Analyses were particularly concerned with the localization of centromeres to determine the relative length of chromosome arms; measurements were also taken of the lengths of individual chromosomes. Chromosomes of pairs 2, 3, 4, 6, and 7 of the translocated form were found to be highly similar to the control form in respect to arm length of the chromosomes and to the mutual proportions of arms within different chromosomes. Within the karyotype of the examined translocated form, it was found that chromosomes corresponding by their parameters with the chromosomes of pairs 1 and 5 of the control form occurred singly and possessed within the karyotype no close analogs; they were replaced by other chromosomes that corresponded by the length of their shorter arms with chromosomes of pairs 1 and 5, yet had altered dimensions of the longer arms and an altered relation of arms. It was concluded that in respect to the length and relation of arms, the altered chromosomes arose due to translocation that occurred between normal chromosomes of pairs 1 and 5; the translocation took place in the longer arm of these chromosomes. (C.O.)

26746 DEVELOPMENT OF CYTOGENETICS: ITS PROBLEMS AND ACHIEVEMENTS. Skalinska, M. (Univ. of Krakow). Genet. Pol., 8: 115-29(Dec. 1967).

The importance of cytology for the development of modern genetics is reviewed. Cytological methods for studying ploidy, meiosis, mitosis, embryogenesis, gametogenesis, chromosome duplication, and mutagenesis (radioinduced mutations) are discussed in relation to their contributory nature. (C.O.)

26747 RADIOMIMETIC EFFECTS OF VERATRUM. Sax, Karl (Univ. of Georgia, Athens); Sax, Hally J.; Binns, Wayne. Toxicon, 6: 69-70(Aug. 1968).

The effects of a teratogenic agent in Veratrum species were compared with those of γ rays. Veratrum (False Hellebore) species have long been known to produce toxic effects in animals which eat the plants. *V. californicum* contains a teratogenic agent causing cyclopia-type malformations in lambs and calves when maternally ingested on the 14th day of gestation. Since toxic agents which cause birth defects may be radiomimetic, the effect of *V. californicum* was tested on onion root tip chromosomes. Chromosome aberrations were scored at anaphase and included acentric fragments and dicentric bridges. The aberration frequency for the controls ranged from 1.3 to 1.9 per 100 anaphases, with an average of 1.7. The frequency for the *V. californicum* tests ranged from 6.3 to 8.8 with an average of 7.8. The net aberration frequency induced by the *V. californicum* solution was 6.1. An aberration frequency of 6 per 100 anaphases is produced by exposing the growing root tips to a chronic dose of γ radiation of 20 Rad/day. *V. viride* from the eastern part of the United States is not teratogenic, and several tests indicated that it is not radiomimetic. Other agents which produce birth defects may also produce chromosome aberrations, as does ionizing radiation. (BBB)

26748 STUDIES ON CELL RADIOBIOLOGY. I. MORPHOLOGICAL AND CHROMOSOMAL CHANGES IN X-IRRADIATED HeLa CELL CULTURES. **Cilievici, Olga; Leahu, L. (Faculty of Medicine, Bucharest). Arch. Roum. Pathol. Exp. Microbiol., 26: 441-52(June 1967).**

Under the influence of x-ray doses of 500 R the nearly tetraploid population in a HeLa 2 cell culture became hypertetraploid (90 to 100 chromosomes per cell) and highly polyploid, reaching a number of 240 chromosomes per cell. It is suggested that in hypertetraploid mononucleate giant cells the mechanism by which they develop is primary endoreduplication by the formation of diplochromosomes. The highly polyploid cells appear to be formed by multipolar mitoses and the blockage of cytodieresis. These results support those in the literature according to which in vitro cell populations are heterogenous, formed of a multitude of genotypes, each of which manifests itself by a specific mechanism. This mechanism is transmitted to the progeny of the irradiated cell. (BBB)

26749 SELECTION OF MUTANTS OF BACILLUS SUBTILIS BLOCKED AT THE BEGINNING OF SPORULATION: NATURE OF THE SELECTED MUTANTS. **Michel, Janine F.; Cami, Brigitte (Institut Pasteur, Paris). Ann. Inst. Pasteur, 116: 3-18(Jan. 1969). (In French).**

Three types of asporogenous mutants induced by uv irradiation, treatment with N-mustard, or with nitrous acid-treated DNA, and selected by previously described methods were studied. All the mutants tested were one-step mutants, belonging to three distinct loci; at least one punctual mutant was found within each selected type. Of the three distinct phenotypes, at least 2 (spo_A^- and spo_B^-) were pleotropic. The reversion to the sp^+ state by mutants of different types spontaneously and by uv irradiation is reported. The very low spontaneous reversion ($< 7.5 \times 10^{-11}$) was augmented by uv irradiation. The possible meaning of these mutants in terms of the regulation process is discussed. (BBB)

26750 DIE CHROMOSOMENMUTATIONEN. (Chromosome Mutations). Rieger, Rigomar; Michaelis, Arnd. Genetik: Grundlagen, Ergebnisse und Probleme in Einzeldarstellungen. Beitrag 6. (Genetics: Principles, Results, and Problems in Single Presentations. Contribution 6). Jena, Ger., VEB Gustav Fischer Verlag, 1967. 433p. M51.50.

The various types of chromosome structure disorganizations, their origin, their detection, and their effects on the cell and the organization are reviewed. The literature up to the end of 1965 was considered; results of later studies appear to some extent in footnotes. A brief review is first given of the structure and fine structure of chromosomes. The general interpretation of the origin of chromosome structure modifications is given. Detection methods used for chromosome aberrations are described. Spontaneous chromosome aberrations are considered. The experimental induction of chromosome structure modifications is examined in detail. The meiotic behavior of karyotypes in which chromosome modifications are hetero- or homozygous is discussed. (J.S.R.)

26751 BIOLOGICAL EFFECTS OF UV RADIATION ON MICROORGANISMS. Pietrzykowska, Irena (Inst. of Biochemistry and Biophysics, Warsaw). Postepy Biochem., 13: 171-89(1967). (In Polish).

Effects of uv radiation on microorganisms are reviewed (104 references) with particular attention to the nature of the photoproducts (including the thymine dimer), reactions of DNA and its constituents, mechanisms of photoreactivation, and the mode of uv mutagenesis. The dimerization of pyrimidine constituents of bacterial DNA was studied extensively as the likely site of uv-induced inactivation, as was also the reactivation of the DNA in the presence of visible light, apparently mediated by an enzyme-controlled excision of the dimers. This process as it occurred in various bacteriophage strains was examined, especially in relation to the nucleotide base composition of the DNA. The nature of the photoreactivating enzyme was examined, as well as its probable substrate range. The effect of incorporation of base analogs, such as 5-bromouracil, on the photoreactivation process was also considered, as were the effects of various antibiotics on host-cell reactivation of bacteriophage. The mutagenic action of uv radiation on microorganisms was compared to that of physical and chemical agents. (BBB)

26752 GENETICS OF CITRIC ACID-PRODUCING STRAINS OF ASPERGILLUS NIGER. I. CITRIC ACID SYNTHESIS BY MORPHOLOGICAL MUTANTS INDUCED WITH UV. **Ilczuk, Zdzislaw (M. Curie-Sklodowska Univ., Lublin). Acta Microbiol. Pol., 17: 331-6(1968).**

Twenty-one *A. niger* strains of different acid-forming activity and three industrial strains were irradiated with a Philips TUW-30 bulb at a distance of 25 cm for an exposure time of 45 to 90 min. A total of 131 morphological mutants was obtained from conidia as a result of uv irradiation; 71.8% of the mutants had white conidia, 16.0% brown, 6.9% grey, 3.8% olive, and 1.5% yellow. No correlation was found between the color of conidia and the ability to synthesize citric acid. However, among mutants there was a high percentage (55%) of forms characterized by an increased ability to produce the acid as compared with corresponding wild strains. In one instance citric acid production was increased 214%. The *A. niger* strains with changed color of conidia may prove to be more stable with regard to their newly acquired characteristics than the so-called physiological mutants in which the stability of this feature (citric acid production) is not that expected in real mutants. (BBB)

26753 INDUCTION BY ULTRAVIOLET IRRADIATION OF MUTATION IN THE BLUE-GREEN ALGA NOSTOC LINCKIA. Singh, R. N.; Tiwari, D. N. (Banaras Hindu Univ., India). Nature (London), 221: 62-4(Jan. 4, 1969).

A mutation is reported which was induced by uv irradiation, leading to true branching in the typically unbranched genus Nostoc of the order Nostocales. The finding of this mutation leading to true branching and also lateral heterocysts in the unbranched genus Nostoc casts doubt on the accepted use of these characteristics as a means of distinguishing between the orders Nostocales and Stigonematales, and confirms one of the many problems associated with the Cyanophyceae. (UK)

26754 NATURAL AND INDUCED MUTATION IN CHLORELLA. Shevchenko, V. A. Usp. Sovrem. Genet., No. 1, 246-78(1967). (In Russian).

A survey is presented of natural mutation in Chlorella, its rate, the dynamics in aging cultures, and survival and mutation processes under the influence of mutagenic factors, i.e., uv light, x ray, and ethylenimine or other chemicals, applied for the purpose of selecting productive, thermophilic or radioresistant Chlorella strains. The nature of cellular radiation injury depending on dose and chromosomal aberrations and genetic changes appearing after irradiation are surveyed in detail. A comparison of the various mutagenic effects showed that x ray and more so ethylenimine produced the highest rate of mutation with least mortality while uv light caused the lowest rate of mutation and highest mortality. The mutagenic effect of the chemical was characterized by the prevalence of sectional mutant colonies within whole colonies of pigmental mutations, pointing toward its effect on serial reproductive processes; it caused mutation at doses that did not affect survival rates (e.g., 0.025% at five hr exposure caused 49.9% mutation for LARG-1 without affecting survival). Ultraviolet radiation and chemical selection with 1,4-bis-diazoacetylbutane enabled the acquiring of the highly productive chlorella strains LARG-1 (*Chlorella vulgaris*), a double mutant of strain B-45 from Lake Baikal, and LARG-2 (*Chl. ellipsoidea*) from strain 21g obtained from a hot spring near that lake; their productivity was triple and double that of the respective original strains. It was concluded that the use of mutagenic factors considerably broadened the possibilities for selecting chlorellas. (ATD)

26755 ENDOSPERM MUTATIONS INDUCED BY UV IN CORN. **Fujii, Taro (National Inst. of Genetics, Misima, Japan). Annu. Rep. Nat. Inst. Genet. Jap. (Engl. Ed.), No. 17, 117-18(1967).**

A wild strain (Bz) with a bronze color of endosperm and a recessive homozygotic strain (bz) were used. Pollen grains of the dominant line were irradiated by uv rays (2537 Å) at a dose rate of about 140 erg/mm^2/sec. Just after irradiation, half of the irradiated pollen grains was exposed to visible light of 6500 lux for 30 min, and the pollen was crossed with a recessive strain under the sun light (PR treatment). The other half of the irradiated pollen was held for 30 min in darkness and pollination with recessive strain was done in a dark room (dark treatment). For comparison, γ-ray irradiated pollen grains were pollinated after PR or dark treatments in the same manner as in uv irradiations. The whole mutation (endosperm wholly deficient for the dominant character) and fractional mutation (endosperm with partially Bz and bz characters) were evaluated. In the γ-ray treated lots, mutation rate in the higher dose lot was higher than for a linear relation. Frequency of fractional and whole mutations was almost the same in each lot and these frequencies were not much different between PR and dark treatment. On the other hand, dose vs mutation frequency was almost linear in uv-treated lots, and frequency of fractional mutation was higher than that of the whole one in each lot after dark treatment. Frequency was markedly decreased according to the PR treatment but the rate of fractional mutation was still high. (BBB)

26756 ON THE SOMATIC VARIATIONS IN CORN AND CHRYSANTHEMUM UNDER CHRONIC γ IRRADIATION. Matsumura, Seiji; Fujii, Taro (National Inst. of Genetics, Misima, Japan). Annu. Rep. Nat. Inst. Genet. Jap. (Engl. Ed.), No. 17, 115-16(1967).

Heterozygotic F_1 seeds from the cross between normal green (Yg_2) and yellow green mutant (yg_2) of corn, and white flowering variety of chrysanthemum, were planted in a γ-greenhouse, and the relation between the frequency of somatic mutation or variegation and dose rate effect were examined. Radiation intensity was 0.29 to 3.06 R/hr, total irradiation time being 1741 hr; total dose in each lot was 430, 910, 2370, and 4500 R. In corn, $Yg_2 \rightarrow yg_2$ mutation was detected by yellow green stripes on leaves. Lengths of mutated stripes were different according to the developmental stage and occurrence of mutation; the number of the stripes longer than 1 cm was counted. Dose vs mutation frequency showed an almost linear relation. Somatic variegation in chrysanthemum from white to yellow was observed in many flowers. When the variegation occurred in early stages, yellow sectors appeared on several ray flowers and when it occurred in late stages streaks appeared on single ray flowers. The dose vs variegation curve also showed an almost linear relation like that in corn. No dose rate effect was observed in the experimental range namely 0.29 to 3.06 R/hr. (BBB)

26757 PHOTOREACTIVATION OF UV-INDUCED MUTATION IN MAIZE. **Matsumura, Seiji; Mabuchi, Tomoo (National Inst. of Genetics, Misima, Japan). Annu. Rep. Nat. Inst. Genet. Jap. (Engl. Ed.), No. 17, 112-13(1967).**

A normal maize strain (Su) with the sugary endosperm gene of a local variety and a recessive line (su) of Golden Cross Bantam were used in this study. Data were obtained from experiments with uv or γ-ray-induced mutations at Su locus after visible light (VL) and dark posttreatments. The percentage of seed set was high after 550 or 1100 R doses of γ rays, while it decreased with the increase of uv dose to about 50% of the control lot at the highest dose (8.1×10^3 erg). Induced whole (endosperm wholly deficient for the dominant character) and chimeric mutants (endosperm consisting partially of su and Su phenotypes) were scored separately for VL and dark posttreatment. No marked differences in the frequency of whole and chimeric mutants between VL and dark posttreatments were observed. As to the frequency of the two types, whole mutation was more frequent than the chimeric one. The frequency of chimeras fits roughly a linear relation with increasing doses, while it is exponential rather than linear for whole mutation. The frequency of mutations induced by γ irradiation was not affected by subsequent VL treatment either for whole or chimeric mutants. On the other hand, the frequency of whole and chimeric mutations from uv irradiation showed an almost linear relation. The frequency of whole mutation was considerably decreased to about $\frac{1}{3}$ by exposure to visible light, while there was no marked difference in the frequency of chimeras between VL and dark posttreatment. (BBB)

26758 PHOTOREACTIVATION OF UV-INDUCED DAMAGE IN MAIZE POLLEN. **Amano, Etsuo; Mabuchi, Tomoo (National Inst. of Genetics, Misima, Japan). Annu. Rep. Nat. Inst. Genet. Jap. (Engl. Ed.), No. 17, 114-15(1967).**

Proof for photoreactivation of uv-induced mutations in maize pollens was obtained, and damage was produced using linked endosperm marker genes on chromosome 9, C, sh, bz, and wx, located on the short arm of chromosome 9 in this order, C being the most distal. Pollen of a multiple dominant stock, C^1 Sh Bz Wx, was irradiated in a single layer in a Petri dish with uv light from a germicidal lamp at a dose rate of 136 erg/mm²/sec for 30, 60, or 90 sec. Immediately after the uv treatment, half of the pollen was exposed to visible light from two 400-W highpressure mercury fluorescent lamps for 30 min. Photoreactivation of uv-induced damage was observed as lowered mutation frequencies in the groups which were treated with visible light after uv irradiation compared to the groups without the postexposure to visible light. Contrary to the previously reported results on su locus, in which whole kernel type showed more photoreactivation, the present results showed more photoreactivation in fractional or sectorial loss of the dominant phenotypes than in whole kernel type. This discrepancy might be caused by the difference of the stocks used, commercial variety vs genetically pure strain, or the systems used, single specific locus or multiple loci. As for the type of damage which could be repaired by the post exposure to visible light, simultaneous loss of a few neighboring marker genes and B-F-B type mosaics were reduced by the post exposure. This suggests that some of the uv-induced damage which would result in chromosome breakage might be repaired by post exposure to visible light. (BBB)

26759 EFFECT OF CHRONIC IRRADIATION UPON A SELF-INCOMPATIBLE CLONE OF LYCOPERSICUM PERUVIANUM. **de Nettancourt, D.; Ecochard, R. (EURATOM-ITAL, Wageningen, Netherlands). Theor. Appl. Genet., 38: 289-93(1968).**

A radioinduced increase in seed-set/plant was observed during chronic irradiation of a self-incompatible clone of L. peruvianum and which appeared to be a direct effect of irradiation upon floral abscission processes. Flowering plants were exposed during 90 days to different dose rates of γ rays ranging from 2 to 17 Rad/hr from ^{137}Cs. Irradiation was continuous, except for a daily interruption of 7 hr. Whereas irradiation at dose rates higher than 7.50 Rad/hr seriously inhibited bud formation and floral development, chronic exposure at dose rates ranging from 3 to 7 Rad/hr increased the number of seeds/plant. This stimulation was not due to a higher number of seeds/fruit but to a significant rise in the number of fruits/plant. As irradiation treatment did not significantly increase the number of flowers/plant and did not appear to stimulate pollen tube germination in the styles, it was concluded that the increase in fruit setting resulted from a radioinduced inhibition of the processes which control floral abscission in the absence of cross-pollination. Three plants with reduced self-incompatibility and one completely parthenocarpic individual were observed in the M_2 progeny, but no evidence was obtained that irradiation could induce a permanent type of self-compatibility in L. peruvianum. (BBB)

26760 NONRECIPROCAL RECOMBINATION IN CHLAMYDOMONAS REINHARDI. **Arnold, Carl-Gerold; Ranneberg, Helga (Univ., Erlangen-Nuernberg, Ger.). Ber. Deut. Bot. Ges., 80: 512-16(1967). (In German).**

Effects of γ irradiation on recombination frequencies in Chlamydomonas reinhardi are reviewed and summarized briefly. Following irradiation with sublethal doses of 3080 R, given at a rate of 770 R/min, of synchronized zygospores obtained from crossing of a wild type with a p-aminobenzoic acid mutant immediately before the beginning of the germination phase nonreciprocal recombinations amounted to 6.4%, as compared to 18.2% in unirradiated zygotes. When zygotes of the mutant-mutant crossing were irradiated, no wild types were produced. In diploid stages of Chlamydomonas there were only two relatively brief periods when reciprocal and nonreciprocal recombinations could be affected by γ irradiation. The first sensitive period was just before the start of the leptotene period, and the second was the pachytene period. However, the crossing-over values were increased by irradiation only during the second period and reduced by irradiation during the first period of sensitivity. (BBB)

26761 THE ENHANCEMENT OF THE MUTAGENIC EFFECT OF ULTRAVIOLET RADIATION IN ESCHERICHIA COLI BY CAFFEINE AND ACRIFLAVINE. **Vechet, B. (Inst. of Microbiology, Prague). Folia Microbiol. (Prague), 13: 379-90(Oct. 1968).**

The mutational synergism of caffeine and acriflavine was studied in five types of E. coli mutants induced by uv radiation. The following types of mutations were compared: streptomycin-resistance (strain B/r), streptomycin-independence (strain Sd-4), and reversions to prototrophy (strains WP-14 pro$^-$, WP-2 try$^-$, and WP-2 try$^-$ hcr$^-$). In all hfr$^+$ strains tested the presence of caffeine or acriflavine in a postirradiation plate medium slightly decreased the survival of uv-irradiated cells and increased considerably the frequency of uv-induced mutations. The mutational synergism of caffeine and acriflavine in the str-r and str-i mutants was observed only within the range of low doses. The dose-dependence of the synergistic effect was discussed from the point of view of qualitative difference between the premutational damage caused by low and high doses. Postirradiation treatment by caffeine slightly increased the frequency of induced prototrophs also in the WP-2 hcr$^-$ strain. This finding is explained by the inhibition of the residual HFR activity of the strain. Postirradiation mutational synergism of acriflavine was not found in the WP-2 hfr$^-$ strain. (BBB)

26762 CONTRIBUTIONS TO THE PROBLEM OF PLASTID CHANGE. V. ANOTHER ^{35}S-INDUCED NUCLEAR GENE MUTANT EFFECTING PLASTID CHANGES. **Michaelis, P. (Max-Planck-Institut fuer Zuetungsforschung, Cologne). Theor. Appl. Genet., 38: 314-20(Oct. 21, 1968). (In German).**

Seeds of Epilobium hirsutum were treated with 0.5 mCi of ^{35}S, a sublethal dose. One treated plant gave rise to variegated plants when selfed. Crosses revealed that this was caused by the recessive gene mp_2 that induces plastid mutations. The conclusion that the observed variegation was due to mutations of the plastids was based on characteristic patterns of the leaves and the occurrence of mixed cells. Maternal inheritance of the mutated plastids could not be demonstrated as the mp_2 gene induces most of the plastid mutations too late in the development of the leaves to exert an effect on the shoots and cell lines giving rise to egg cells. (BBB)

26763 INDUCTION OF SOMATIC MUTATIONS IN COSMOS BIPINNATUS BY INTERNAL BETA IRRADIATION FROM INCORPORATED RADIOPHOSPHORUS. **Gupta, M. N.; Matsuo, T. (Tokyo Univ.). Radioisotopes (Tokyo), 18: 56-9(Feb. 1969).**

The mutagenic effects of internal β irradiation on meristematic cells of Cosmos bipinnatus following absorption of ^{32}P were observed. Tabulated data are presented on plant height five weeks after treatment; total number of flowers produced; percentage of flowers with color mutations; and flowers with physiological injuries and morphological abnormalities. Somatic mutations were observed in clone I by the appearance of white and red streaks on a background of normal pink color ray florets. In clone II, mutant streaks of white and pink color were observed on a background of normal red color ray florets. In general, the reduction in plant height increased with the increase in the dose of radioisotope. At higher doses, the number of flowers per plant was greatly reduced during summer and autumn; the percentage of mutated flowers decreased with the increase in dose. The percentage of flowers with physiological injuries and morphological abnormalities increased with the increase in radioisotope dose in both clones. (C.O.)

26764 EFFECTS OF THERMAL NEUTRONS AND GAMMA RAYS ON SEEDS OF ANTIRRHINUM MAJUS AND THEIR MODIFICATION BY WATER CONTENT AND OXYGEN CONCENTRATION. Gupta, M. N.; Matsuo, T. (Tokyo Univ.). Radioisotopes (Tokyo), 18: 52-5(Feb. 1969).

The mutagenic effects of different exposures of thermal neutrons and γ rays on F_1 seeds of Antirrhinum majus and the subsequent modifying effects of water content and oxygen abundance were investigated. Data were recorded on the percentage of germination of seeds, survival and percentage of abnormal seedlings, and height of seedlings. Results showed that soaked seeds were much more sensitive to radiation than dry seeds and that the injurious effects of radiation increased when seeds were irradiated in the presence of oxygen as compared with nitrogen. (C.O.)

Health Physics and Safety

Refer also to abstracts 28065, 28501, and 28530.

26765 STATEMENT OF HEALTH PHYSICS SOCIETY BOARD OF DIRECTORS REGARDING MODIFIED AEC PROPOSAL FOR CENTRAL REPOSITORY OR RADIATION EXPOSURE RECORDS. Health Phys., 16: 661(May 1969).

The Health Physics Society recognizes the statutory responsibility of the U. S. Atomic Energy Commission to protect the health and safety of the public and of its employees with regard to radiation exposure resulting from atomic energy programs. The Society believes that the revised and limited system proposed by the AEC for collecting annual exposure information on certain industrial categories of employees, and for submitting individual employee exposure histories upon termination of employment, is a reasonable and economical compromise between current professional views on central radiation exposure record keeping. Certain criticisms are, however, made. The Health Physics Society has repeatedly urged, and continues to urge, the establishment of a professional and scientific advisory council for consideration of problems of radiation workers, and is ready to help in this important matter if requested. (auth)

26766 RADIOLOGICAL HEALTH DATA AND REPORTS. Radiol. Health Data Rep., 9: 145-94(Mar. 1968). (RHD-(Vol.9)-(No.8)).

Data and reports provided to the National Center for Radiological Health by Federal agencies, State health departments, universities, and foreign governmental agencies are presented. Separate abstracts were prepared for each section. (D.H.M.)

For abstracts of individual sections see: 26361, 26372, 26373, 26777, and 26778.

Radioactive Contamination and Decontamination

Refer also to abstracts 26361, 26373, 26686, 26816, 26817, 28552, and 28561.

26767 (IDO-12065) CONTROLLED ENVIRONMENTAL RADIOIODINE TESTS AT THE NATIONAL REACTOR TESTING STATION: 1967 CERT PROGRESS REPORT. Progress Report No. 4. Zimbrick, J. D.; Voilleque, P. G. (eds.) (Idaho Operations Office (AEC), Idaho Falls). Jan. 1969. 78p. Dep. CFSTI.

The experimental and theoretical research undertaken during 1967 as part of the Controlled Environmental Radioiodine Test (CERT) program is described. A brief description of the historical development of the program and a summary of the principal results prior to 1967 are included. A mathematical model of bovine metabolism of ^{131}I, based on the model proposed by Garner, is developed. Comparison of the predictions of the model with CERT data indicate that the model is adequate for the purpose of predicting the quantity of radioiodine found in milk. CERT experimental data on deposition are compared with the predictions of Sheppard's flux gradient model and with Chamberlain's resistance analogue of deposition. The Chamberlain model appears adequate for carbon plate deposition. Both models are inadequate for describing deposition on grass. The measured median deposition velocities for two simultaneous releases over two separate but adjacent grids were found to be within 20% of one another. Deposition velocity was found to be linearly related to both areal grass density and mean wind speed. The results of calculations of the ratio of the dose to the thyroid resulting from ingestion of milk from cows eating contaminated grass to the dose of the thyroid resulting from the inhalation of the contaminated air above the grass at the time of deposition are included. (auth)

26768 (MORP-68-5) USE OF RADIUM IN CONSUMER PRODUCTS. Robinson, Earl W. (National Center for Radiological Health, Rockville, Md.). Nov. 1968. 25p. GPO $0.40.

The extent of the use of radium in products available to the public, and the potential hazards of such products, are discussed. The use of radium in self-luminous compounds is emphasized. The disposal of government surplus property containing radium, and the subsequent retail sale of this material, are identified as potential hazards to the public. By-product material is being widely substituted for radium in self-luminous products; radiation characteristics of radium-226, promethium-147, and tritium are compared. (auth)

26769 (NP-17777) DATA FROM RADIATION PROTECTION PROGRAMS. Volume 6, Number 8. (Department of National Health and Welfare, Ottawa (Ontario). Radiation Protection Div.). Aug. 1968. 21p. Dep.

Fallout monitoring data on the atmosphere, precipitation, milk, water, wheat, soil, and human bone are tabulated. The average fallout values for July, 1968, showed little change from those of the previous month. The average content of ^{137}Cs and ^{90}Sr in liquid milk were 28 pCi/l and 11.9 pCi/l respectively, compared to 26 pCi/l and 11.8 pCi/l respectively for June, 1968. (C.O.)

26770 (NP-17819, Chap.4) SAFETY. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)). 7p.

The Health Physics department pursued work on the general environment inventory such as measurement of the radioactive fallout in Belgium and a contract with the Ministry of Public Health on the alimentary chain. Radioactive contamination of the Scheldt estuary and the biological cycle followed by radioactivity were further studied in cooperation with different national and international organizations. The theoretical laws of atmospheric diffusion were tested by experiments. Advanced detection methods and equipment were developed for Pu-contaminated lungs, biological samples, and wounds. In the field of waste disposal research two Euratom contracts covering soil studies and separation of fission products by inorganic ion exchangers were pursued. The S.C.K./C.E.N. waste disposal service, operated by Belgo-Nucléaire, devoted the largest part of its research activities to physico-chemical studies of Nethe river sediments. (auth)

26771 THE ^{222}Rn CONCENTRATION IN THE ATMOSPHERES OF MINES AS A FUNCTION OF THE BAROMETRIC PRESSURE. Pohl-Rueling, Johanna; Pohl, Egon (Research Inst. Gastein, Innsbruck). Health Phys., 16: 579-84(May 1969).

Investigations in three European mines showed that the radon content of the atmosphere in the mines rises as the barometric pressure drops and decreases when the pressure rises or when it remains constant. It is shown how to calculate supply and removal of radon. The supply consists of a permanent and a variable component. The permanent supply comes from the surface of the rock and depends on its ^{226}Ra content and its nature. The variable supply originates from within the rock and is a function of the suction effect of decreasing barometric pressure, but also depends on the nature (e.g., porosity and fissures) of the rock. The radon removal depends on the natural and artificial ventilation rates, apart from the natural radioactive decay. Such calculations can be useful in order to determine the ventilation requirements, permitting regulation according to the variation of barometric pressure. (auth)

26772 CHELATION-ENHANCED EXCRETION OF RADIOACTIVE DAUGHTERS OF THORIUM. Young, Irving; Cherry, Norman H.; Winsten, Seymour; Sklaroff, David Mann (Albert Einstein Medical Center, Philadelphia). Ann. N. Y. Acad. Sci., 145: 642-3(Dec. 11, 1967).

From Conference on Distribution, Retention, and Late Effects of Thorium Dioxide, New York. See CONF-660422.

An attempt was made to promote the excretion of radioactive deposits from a man who had substantial body deposits of thorium dioxide. The patient had had cerebral angiography five yrs earlier. The administration of Ca EDTA (2 to 3 g per intravenous dose in a total of 10 doses) over a 15 day period enhanced the urinary excretion of the ^{212}Pb but did not seem to appreciably reduce the body burden of thorium dioxide. (M.M.B.)

26773 STUDY OF RADIOACTIVITY IN THE ENVIRONMENT OF THE NATIONAL NUCLEAR RESEARCH CENTRE, PELINDABA. van As, D.; Basson, J. K. (Atomic Energy Board, Pretoria). S. Afr. J. Sci., 65: 3-16(Jan. 1969).

The normal operation of most nuclear research centers, especially where a reactor is in operation, is unavoidably accompanied by the production of some radioactive waste and the resultant release of a certain measure of radioactivity to the environment. Surveys of the environmental radioactivity of the National Nuclear Research Center, Pelindaba, where the research reactor SAFARI 1 went critical on March 18, 1965, have therefore been carried out since late 1963. These surveys include the study of total alpha and beta activities as well as specific nuclides in a wide range of media, their variation with season, as well as the determination of nuclear bomb fallout. The purpose, extent and value of such district monitoring is discussed and the results considered in the light of their value in tracing radioactive contamination of the biosphere. A method of variance analysis has been developed to indicate abnormal values requiring further determination. Subsequently the whole environmental survey is critically analyzed and curtailed to a minimum routine program, supported by special investigations. (auth)

26774 DISTRIBUTION OF RADIOACTIVE SUBSTANCES IN MARINE ORGANISMS AND ASSOCIATED TISSUES. Zesenko, A. Ya. pp 210-18 of Voprosy Biookeanografii. Materialy II Mezhdunarodnogo Okeanograficheskogo Kongressa, 30 Maya-9 Iyunya 1966 g, Moskva. Kiev, Izdatel'stvo Naukova Dumka, 1967. (In Russian).

From 2nd International Oceanographic Congress, Moscow, USSR. See CONF-660574.

To determine the uptake and distribution of radionuclides in sea fauna, indicator organs such as tissues must be examined. The biogeochemical role of the hydrobionts in the sea, and the biological functions of rare elements must also be considered together with the dosimetry and the internal effects of incorporated radionuclides. This problem was studied by determining the uptake coefficients and the distribution of 11 radionuclides in *Carcinus maenas* crabs and *Mytilus galloprovincialis* molluscs, as well as ^{95}Zr and ^{106}Ru in *Diplodus annularis* and *Odontogadus merlangus ponticus* fish. The uptake of nearly all radionuclides reached equilibrium within eight to 16 days after the start of the experiments. A correlation was derived between the uptake coefficients and the distribution parameters of the radionuclides in the organs and tissues of marine animals. This data permitted calculation of the concentrations of the nuclides in the whole body, organs, tissues, and whole populations, without making specific isotopic analyses. Data were obtained on the rate of passage of seawater through the branchial filters of molluscs. In the absence of phytoplankton and low-dispersion suspensions in the water, the filtering purification of the medium by molluscs from radioactive isotopes was negligible. (TTT)

26775 AGENT FOR MECHANICALLY COLLECTING AND REMOVING RADIOACTIVE CONTAMINANTS. (to Collo-Rheincollodium Koln Gesellschaft mit Beschrankter Haftung Werk Hersel). British Patent 1,135,264. Dec. 4, 1968. Priority date Jan. 23, 1965, Germany.

A material for mechanically collecting and removing radioactive contaminants from the skin or other objects consists of a foamed material with pores having a cell size of 0.2 to 3 mm with at least one surface being open-pored and of a hardness such that the cell walls form a scraping edge that crumbles away when rubbed on the object to be decontaminated. The open-pored foamed material is preferably a foamed synthetic thermoplastic, thermosetting plastic, or rubber; however, an inorganic substance such as glass or slag may be used. The efficiency of the granules or powders can be increased by incorporating into them other materials that will increase the ease of removal of contaminants, such as detergents, soaps, etc., or an adsorbent or adsorbent material, such as activated charcoal or ion-exchange material. (B.L.M.)

26776 INDUCED RADIOACTIVITY IN MARINE ORGANISMS IN VARIOUS SEAS AND OCEANS. Parchevskii, V. P. pp 198-209 of Voprosy Biookeanografii. Materialy II Mezhdunarodnogo Okeanograficheskogo Kongressa, 30 Maya-9 Iyunya 1966 g, Moskva. Kiev, Izdatel'stvo Naukova Dumka, 1967. (In Russian).

From 2nd International Oceanographic Congress, Moscow, USSR. See CONF-660574.

Data on the radioactivity of organisms and of the water from the Black Sea, Atlantic Ocean, and Indian Ocean, obtained by researchers of the Division of Radiology of the Institute of the Biology of Southern Seas were compared with similar data reported by other investigators. Lack of specific information concerning the species and the time of determination in the literature made the comparison difficult, except for ^{90}Sr. Examination of the ^{90}Sr content of certain algae, flowering plants, molluscs, crustacea, and fish, collected during 1961 to 1965 revealed that the shells of molluscs and crabs possessed the largest amount of ^{90}Sr, of the order of tens to hundreds of pCi/kg of wet weight; 1 to 10 pCi/kg of ^{90}Sr was found in sea fish and minnows. On the basis of data from brown algae it was established that in 90% of cases the concentration of ^{90}Sr in the Black Sea, the littoral waters of Japan, and the Gulf of Mexico varied only by a factor of one to three; the same values in the same percent of cases in the Irish Sea varied by a factor ranging from 10 to 600. Thus, ^{90}Sr is very unevenly distributed in the oceans of the world. The observed increase of the ^{90}Sr concentration in the hydrobiont of the Ligurian, Adriatic, and Black Seas was found to follow the same mathematical relationship. (TTT)

26777 MILK AND FOOD. Radiol. Health Data Rep., 9: 153-67(Mar. 1968).

Data from selected national, international, and state milk and food surveillance activities are presented. Data from the Public Health Service Pasteurized Milk Network for November, 1967 and for December, 1966 through November, 1967; the Canadian Milk Network for November, 1967; and Pan American Milk Sampling Program for November, 1967 are tabulated. State milk surveillance activities for July through September 1967 are presented for California, Oregon, and Washington. The average dietary consumption and ^{90}Sr intake in Tri-city (New York, San Francisco, and Chicago) diets for January to March 1967 are also reported. (D.H.M.)

26778 ^{210}Po IN TOBACCO. Black, Stuart C.; Bretthauer, Erich W. (Southwestern Radiological Health Lab., Las Vegas, Nev.). Radiol. Health Data Rep., 9: 145-52(Mar. 1968).

Variations of ^{210}Po content in tobacco, the amount of ^{210}Po in various fractions of smoked cigarettes and changes in ^{210}Po content of mainstream smoke caused by variation in the smoking procedure were determined. The average ^{210}Po content for whole cigarettes was found to be 0.483 pCi/gram and 0.477 pCi/gram for butts. No ^{210}Po enrichment in the butt of cigarettes during smoking was found. Polonium-210 content and concentration in mainstream smoke increases with puff size. (auth)

26779 DETERMINATION OF THE RADIOACTIVE CONTAMINATION OF FODDER IN RELATION TO ATMOSPHERIC PRECIPITATIONS. Orlando, G.; Bixio, D.; Deveris, B. (Univ., Genoa). G. Ig. Med. Prev., 8: 500-5(July-Sept. 1967). (In Italian).

The γ spectra of hay samples and rain water in two areas of Savona Province have been measured. The results showed that radiocontamination of hay is proportional to the entity of rainfall and not to its specific activity. (auth)

26780 INFLUENCE OF PRESERVATION AND STORAGE ON RADIOZINC AND TOTAL ZINC CONCENTRATIONS IN FISH. Renfro, William C.; Phelps, Roger V.; Guthrie, Thomas F. (Oregon State Univ., Corvallis). Contract AT(45-1)-1750. Limnol. Oceanogr., 14: 168-70(Jan. 1969). (RLO-1750-25).

Total Zn and ^{65}Zn were measured in tissue samples of perch (*Cymatogaster aggregata*) and flounder (*Platichthys stellatus*) from the Columbia River estuary. The effects of freeze preservation and formalin preservation on the content of total Zn and ^{65}Zn resulted in wide variations in results. The content of ^{65}Zn and total Zn in freeze-preserved fish was about 40% less than in either fresh fish or fish stored in formalin for one year. It was concluded that data from the analyses of fish samples stored for long periods should include the method of preservation. (C.H.)

26781 ^{90}Sr AND ^{137}Cs IN SOME FINNISH SOIL PROFILES. Haekkinen, Ulla; Lakanen, Esko (Agricultural Research Centre, Tikkurila, Finland). Ann. Agri. Fenn., 7: 123-6(1968).

The amounts of ^{90}Sr and ^{137}Cs in five undisturbed Finnish soils in 1965 were 26 to 48 and 56 to 103 mCi/km^2 (means 39 and 75, respectively). The corresponding medium depths for 50% leaching were 4.2 and 2.1 cm, which is caused by the low annual rainfall and freezing of soils in winter. (auth)

26782 THE PROBLEM OF EMERGENCY SITUATIONS IN RADIATION HYGIENE. Terman, A. V. Vestn. Akad. Med. Nauk SSSR, No. 3, 43-7(1969). (In Russian).

Emergency situations arising during the use of radioactive substances and sources of ionizing radiation were studied. The emergency itself is interpreted as any situation that has or might have led to an increased possibility of external or internal irradiation of humans, or radioactive contamination of the territory, property and other environmental objects to a degree above the established standard levels. A classification of radiation emergencies is listed contingent upon territories they cover, and also depending upon the gravity of consequences that follow from such emergency situations. Recommendations on the evaluation of irradiation levels permissible under emergency conditions are listed. (auth)

26783 NEW STUDIES ON EXPERIMENTAL CONTAMINATION OF MARINE SPECIES BY ^{137}Cs, ^{106}Ru, AND ^{144}Ce. Ancellin, J.; Vilquin, A. (CEA/DPS, Cherbourg, France). Radioprotection, 3: 185-213(1968). (In French).

Experimental contaminations of marine species by fission products were made at the Laboratory of Marine Ecology, C.E.A.; Department of Health Protection. These studies were designed to make a contribution to the data for formulation of the maximum permissible levels of radioactive wastes in the sea and were based on the concept of concentration factor, expressing the more or less marked capacity of marine organisms to concentrate the radioelements of different origin present in the sea. The ^{137}Cs, ^{106}Ru, and ^{144}Ce contaminations in aquariums were studied on species of algae and invertebrates common in the northeast region of Cotentin. The studies made it possible to determine a number of concentration factors, which were compared with experimental results obtained in other laboratories and with values obtained from measurements made in the natural ecosystems exposed to the effect of radioactive wastes. (tr-auth)

26784 CHANGES IN THE HUMAN BODY BURDEN OF ^{137}Cs IN THE REGION OF PARIS FROM 1964 TO 1967. Fabre, J.; Andrieu, L.; Arnaud, G.; Frossard, H.; Bok, B. (Hopital Militaire d'Instruction, Clamart, France). Radioprotection, 3: 173-83(1968). (In French).

The Cs content in the human body is less than 10^{-5} g. Cesium-137 is an artificial radioelement emitted during the fission of ^{239}Pu and ^{235}U. Its radioactive half life (about 30 years) and the characteristics of its γ emission (660 keV) make it easy to detect. Its incorporation in the food chain, because of world fallout from nuclear tests, has led to an internal human contamination which has varied with the number, the power, and the date of the nuclear tests. The changes in the ^{137}Cs content of man residing in the Paris region were followed from 1964 to 1968. The results are reported. (tr-auth)

Dosimetry and Monitoring

Refer also to abstracts 26554–26557, 26583, 26668, 26713, 26714, 26770, 26920, and 28067.

26785 (FOA-4-4387) STUDIES ON PLANT ACCUMULATION OF FISSION PRODUCTS UNDER SWEDISH CONDITIONS. X. ABSORPTION OF ^{90}Sr AND ^{137}Cs FROM SOIL BY VEGETABLE CROPS. Fredriksson, L.; Loensjoe, H.; Eriksson, A. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Mar. 1969. 31p. Dep.

Studies were carried out on the amount of strontium-90 and cesium-137 in a number of crops, representing leafy vegetables, root crops, cabbages, beans, and others, absorbed under field conditions from two different contaminated soils. It was found that shallow-rooted crops accumulated more of the nuclides than deep rooted crops in morphologically the same type of plant tissues. In relation to calcium a higher strontium-90 content was found in the roots than in the aerial parts of the plants analyzed. The strontium-90 content in edible parts of the crops decreased in the following order: Spinach, Lettuce > Radishes > Beans, Carrots > Beets, Parsnips > Cauliflower, Cabbage > Potatoes. The cesium-137 content decreased in the following order: Lettuce, Spinach, Cauliflower > Radish, Cabbage, Carrots > Parsnips, Beans > Beets, Potatoes. (auth) (Sweden)

26786 IN VIVO MEASUREMENT OF ^{210}Pb AS AN INDICATOR OF CUMULATIVE RADON DAUGHTER EXPOSURE IN URANIUM MINERS. Eisenbud, Merril (New York Univ., N. Y.); Laurer, Gerard R.; Rosen, Jerry C.; Cohen, Norman; Thomas, James; Hazle, Albert J. Health Phys., 16: 637-46(May 1969).

The accumulation of ^{210}Pb in the human skeleton can be measured by in vivo techniques at body burdens greater than about 4 nCi using transportable equipment designed to detect the 47 keV γ-ray from this nuclide. A burden of two nanocuries is shown to be equivalent to a calculated cummulative exposure of about 800 working-level months. The instrumentation utilizes the Laurer system of twin crystal γ spectroscopy in which an 8 in. × 1 mm cesium iodide crystal is optically coupled to an 8 in. × 2 in. sodium iodide crystal and is operated in anti-coincidence on a single photomultiplier tube utilizing the principle of rise-time discrimination. The method of measuring ^{210}Pb and the equations used to estimate the cumulative exposure in working-level months are presented, with an evaluation of the uncertainties and the extent to which the estimates can be improved by additional experimental data. The results of field measurements undertaken on the Colorado Plateau showed that, among 37 control subjects with no history of employment in mines, only one individual had counts in excess of two sigma above the mean in the 47 keV region. In contrast, 26 out of 54 men with uranium mining histories showed counts greater than two sigma above the mean. (auth)

26787 DILEMMA OF LUNG DOSIMETRY. **Parker, H. M. (Battelle-Northwest, Richland, Wash.). Health Phys., 16: 553-61(May 1969).**

A legitimate criticism of health physics arises from the derivation of quite complex relationships for the permissible deposition of radionuclides in the body, in the absence of valid experience in man. It has to be accepted that inhalation of substantial amounts of radon and its daughter products has a finite probability of causing cancer in the bronchial epithelium, but establishment of a quantitative dose-effect relationship has a formidable array of impediments. The radioactive nuclides in mine air comprise a short-lived chain existing in physical forms from free ions through small nuclei to large dust particles. Intake and primary retention of these has to be calculated from models. Subsequent translocation up to the bronchial tree is a significant factor in exposure. If the nucleus of a basal cell of bronchial epithelium is assumed to be the biological target, the penetration of alpha particles to it can be modeled with various degrees of sophistication. This leads to a numerical relationship between nature and concentration of the ambient radioactivity and the relevant tissue dose or dose-rate. The quoted number may be high or low by a factor of about three. This is essentially a permissible dose type of calculation; it is not a demonstrated dose–effect relationship. The feasibility of programs to eliminate these uncertainties progressively is discussed in terms of refined studies of mine exposees, relevance of data from radium or other human cases, and animal experimentation. (auth)

26788 A MODEL FOR ESTIMATING THE INHALATION EXPOSURE TO ^{222}Rn AND DAUGHTER PRODUCTS FROM THE ACCUMULATED ^{210}Pb BODY BURDEN. **Fisher, Henry L. Jr. (National Center for Radiological Health, Rockville, Md.). Health Phys., 16: 597-16(May 1969).**

Underground uranium miners are exposed to radon-222 and its daughter products. It has been difficult to determine quantitatively the exposure to these daughter products since the atmospheric concentration varies in time and space. Lead-210, a residual of these daughter products, is held tenaciously by the body. After examining the data on the retention of stable lead in humans, and the retention of ^{210}Pb in dogs, an eight compartment model was developed to describe these data. The model was applied to a set of 32 miners whose exposure history had been estimated, with the result that the body burden of ^{210}Pb was estimated to within an order of magnitude of the experimental results. A computer program was written for the least squares fitting of any retention function to any specified exposure or intake record. This program was used to fit five retention functions to the uranium miner data, with the result that the ^{210}Pb body burden could be estimated to within a factor of 2 with 68% confidence and within a factor of 4 with 95% confidence. (auth)

26789 ERRORS IN MEASUREMENT OF WORKING LEVEL. **Loysen, Peter (Atomic Energy Commission, New York). Health Phys., 16: 629-35(May 1969).**

Errors in determining radiation working levels in uranium mines by the Kusnetz method were investigated as to source and magnitude. These include errors of accuracy and precision associated with the measurement of air sample volume and alpha radioactivity on filter samples, and computation of working level from these two measurements. Appropriate controls are suggested to keep the errors to reasonable levels. Measurements made in uranium mines verify the efficacy of these controls. (auth)

26790 A REVIEW OF BIOLOGICAL RISK DUE TO IONIZING RADIATIONS IN PNEUMOPHTHISIOLOGICAL RADIODIAGNOSIS. Martinotti, G. (Univ., Turin. Univ., Parma, Italy). Minerva Radiol., 13: 639-51(Nov. 1968). (In Italian).

The structure of the pulmonary parenchyma is such that high ionizing radiation doses are not employed in radio diagnosis of diseases of the chest. On the other hand, the existing organization of pneumophthisiological examinations results in exposure to a radiation load that is, in all probability, higher than in any other branch of pathological medicine. The general concept of radiation risk and protective measures are discussed. Literature values relating to absorption on the part of the vital organs, genetically meaningful and genetically acceptable doses are suggested and, bearing in mind the abundant haemopoietic tissue content of the chest skeleton, attention is drawn to marrow radiation uptake and its consequent leucaemogenic effect. Lastly, an account is given of the various forms of examination employed in radiation diagnosis of diseases of the respiratory tract. In each case, the rules to be observed and the precautions to be adopted are described. (auth)

26791 A SURVEY OF RADIATION DOSIMETRY IN THORIUM DIOXIDE CASES. Dudley, Robert A. (International Atomic Energy Agency, Vienna). Ann. N. Y. Acad. Sci., 145: 595-607 (Dec. 11, 1967).

From Conference on Distribution, Retention, and Late Effects of Thorium Dioxide, New York. See CONF-660422.

The objectives, problems, techniques, and results of radiation dosimetry as applied to persons containing Thorotrast are surveyed. Measuring or estimating the radiation dose to organs can be done by many techniques. Living Thorotrast cases can be used for measurement of γ rays emerging from the body, studies of exhaled or excreted isotopes, and analysis of biopsy samples. Supplementary metabolic studies in man and animals give information on the behavior of the Th series of elements in the body. Assay of tissue samples from man and animals who have taken Thorotrast can be made. Data obtained by these techniques and surveyed by Marinelli (meeting on Dosimetry and Toxicity of Thorotrast, IAEA-WHO, Vienna, 1965) are tabulated giving the Th series activity and dose rate in various organs of a man who was intravenously injected with 50 ml of Thorotrast 20 to 25 yrs ago. (M.M.B.)

26792 CALCULATION OF RADIATION DOSE FROM THOROTRAST USING WHOLE-BODY GAMMA-RAY SPECTRAL DATA. Cohn, S. H.; Gusmano, E. A.; Robertson, J. S. (Brookhaven National Lab., Upton, N. Y.). Ann. N. Y. Acad. Sci., 145: 608-22 (Dec. 11, 1967).

From Conference on Distribution, Retention, and Late Effects of Thorium Dioxide, New York. See CONF-660422.

In an epidemiological study of the late effects of Thorotrast in patients, it is necessary to measure the radiation dose to the critical tissues in order to establish a dose-effect relationship. It is thus necessary first to measure the concentration of ^{232}Th and its descendants as a function of time in the critical tissues. The only way that these measurements can be made in vivo at late times after administration of Thorotrast is with whole-body γ spectrometers. From the concentrations of several of the γ-emitting daughters of ^{232}Th in the critical tissues, it is possible to calculate the integral radiation dose to the patient from the date of Thorotrast injection. The technique for obtaining whole-body measurements in patients with Thorotrast burdens, and the computer analyses of their γ-spectral data are described. By means of a computer program, the theoretical in vivo relationships between ^{232}Th and its descendants were calculated as a function of time. Thus the initial amount of ^{232}Th could be deduced from the spectrometric measurements of the ^{228}Ac and ^{208}Tl daughters at any given time. Once this determination was made, it was then possible, by referring to the calculated time pattern of the ^{232}Th decay scheme, to determine the activities of each of the daughters over the time period following administration, and to sum these to obtain an average dose to the liver and spleen. The complex decay scheme of ^{232}Th and the resultant dynamic relationship involving equilibrium, altered by the different metabolic patterns of distribution and excretion of the daughters, introduces a degree of variability into the analysis, but despite this, the method appears most promising and capable of further refinement. (auth)

26793 IN VIVO COUNTING OF THORIUM DIOXIDE PATIENTS: SPECIAL TECHNIQUES AND PRELIMINARY RESULTS. May, Harold; Marinelli, L. D.; Corcoran, J. B. (Argonne National Lab., Ill.). Ann. N. Y. Acad. Sci., 145: 623-33(Dec. 11, 1967).

From Conference on Distribution, Retention, and Late Effects of Thorium Dioxide, New York. See CONF-660422.

Three techniques for in vivo counting of Thorotrast patients are described. They are the ratio method, a coincidence counting technique, and the sum coincidence method. The techniques appear to possess unique advantages and to merit further investigation. (M.M.B.)

26794 INFORMATION ON THOROTRAST DOSIMETRY SUPPLIED BY THE RADIOCHEMICAL ANALYSIS OF TISSUE SPECIMENS. Parr, Robert M. (International Atomic Energy Agency, Vienna). Ann. N. Y. Acad. Sci., 145: 644-53(Dec. 11, 1967).

From Conference on Distribution, Retention, and Late Effects of Thorium Dioxide, New York. See CONF-660422.

Information obtained from radiochemical analysis of macroscopic tissue specimens at various times after injection of Thorotrast is reviewed. Methods are discussed with emphasis on the importance of the time between the removal of the sample or the death of the patient and the beginning of the analysis. Ideally it should not exceed one hr. Results of the analysis of tissue specimens, the uniformity and distribution of thorium-232 within an organ, relative activities of thorium-series isotopes in various organs of the body, and the metabolism of ^{212}Pb and ^{212}Bi are presented and discussed. Mechanisms to explain the escape of isotopes from the particulate phase of Thorotrast are considered. It is concluded that the major uncertainties remaining in the estimation of mean dose rates apply to the kidneys (activities of ^{212}Pb and ^{212}Bi), the lymph nodes (^{232}Th concentrations), and the red bone-marrow (inhomogeneities in ^{232}Th distribution). (M.M.B.)

26795 COSMIC-RAY INDUCED RADIOACTIVITY IN ASTRONAUTS AS A MEASURE OF RADIATION DOSE. Brodzinski, R. L.; Wogman, N. A.; Perkins, R. W. (Battelle Memorial Inst., Richland, Wash.). Space Life Sci., 1: 545-53(Mar. 1969).

The activity-dose-energy relationships for ^{7}Be, ^{13}N, ^{22}Na, and ^{24}Na activities induced in muscle tissue by proton bombardment were measured through the energy range up to 580 MeV. The relationship between radiation dose and induced activity for any given proton bombarding energy is defined. The determination of the radiation dose received by an astronaut from cosmic radiation of unknown energy by measuring the concentrations of the radioactive isotopes induced in his body is discussed. (auth)

26796 DOSIMETRY OF IONISING RADIATIONS UNDER NON-EQUILIBRIUM CONDITIONS. Charlton, David Edward. Saskatoon, Can., Univ. of Saskatchewan, 1967. 168p.

Thesis.

Various models of charged particle energy deposition were developed for making approximate calculations of absorbed dose near interfaces where charged particle equilibrium did not exist. The models presented took into account the increase in stopping power or LET along the particle tracks. Although the assumption of straight-line tracks was retained, the straggling of the actual paths of electrons was taken into account either by assuming that the straight-line range was 70% of the complete track length or by using a distribution of ranges for an electron of a given initial energy. The contribution, from a particular region in which charged particles are liberated, to the absorbed dose in another region may be expressed as the product of three factors: the kerma in the region (the total initial kinetic energy of charged particles liberated per unit mass in the region); the ratio of the mass stopping powers of the region in which the particles deliver their dose to that of the region in which they originate; and an influence function which depends upon the geometry, the linear energy transfer and the range of the charged particle. Influence functions were calculated for electrons and heavy charged particles using the varying LET approximations for a number of geometries. It was shown that these functions could be expressed in a general form, which was independent of the initial energy of the particle, by expressing the geometrical dimensions in terms of the particle ranges. Dose distribution calculated using the influence functions were compared with empirical expressions of R. Loevinger for beta particles and with experimental data. The predictions of the model for electrons were tested by measuring the ionization in an aluminum-walled ionization chamber, irradiated by 100 kVp x rays, using filling gases with atomic numbers (and therefore kerma) both lower (hydrogen and air) and higher (argon) than that of the walls. The effective thickness of the layer of the gas between the walls of the chamber was varied both by changing the separation of the walls and by reducing the gas pressure. The ionization per unit mass of gas was measured absolutely and compared to the exposure in R measured with a calibrated dosimeter. It was therefore possible to compare the absolute values of the ionization as well as the variation with wall separation. For a given effective thickness the ionization per unit mass in air or argon was independent of gas pressure and in good agreement with the values calculated from the appropriate influence functions down to very small plate separations. (auth) (Disser. Abstr.)

26797 ANALYSIS OF THE CALIBRATION TECHNIQUES OF AN X-RAY APPARATUS FOR RADIOBIOLOGICAL EXPERIMENTS. Scarpa, G.; Casnati, E. (Comitato Nazionale per l'Energia Nucleare, Rome). Med. Nucl.-Radiobiol. Lat., 11: 21-9(1968).

Two procedures for the calibration of x-ray sources for use for radiobiological studies were compared. One procedure used ratemeters and a radium standard for measurements performed during a series of six consecutive irradiations of five minutes each; the other procedure used an ionization chamber to measure the dose immediately before and after each experiment. Discrepancies between the dose obtained from the calibration measurements and the actual dose were analyzed statistically. No significant differences were found between the two methods of calibration under the experimental conditions described. (C.H.)

26798 POSSIBILITIES AND RESULTS OF LOCAL DOSE MEASUREMENTS USING FILM DOSIMETERS. Babor, R.; Wachsmann, F. (Gesellschaft fuer Strahlenforschung mbH, Munich). Fortschr. Geb. Roentgenstr. Nuklearmed., 109: 793-802(Dec. 1968). (In German).

The use of film dose meters for local dose measurements in diagnosis and therapy is described. Their advantages are their sensitivity, the possibility of prolonged measurements with a known beam quality, and their cheapness. The results of local measurements in various diagnostic and therapeutic installations in hospitals and in private practice are illustrated by six examples. These show that local dose measurements with films are adequate for radiation protection and to define the areas to be monitored and provide general information regarding radiation protection. (auth)

26799 QUANTITATION OF ABSORBED DOSE PRODUCED AT HIGH AND LOW POTENTIALS. Kort, William B. (Univ. of Illinois, Chicago). Oral Surg., Oral Med., Oral Pathol., 27: 344-8(Mar. 1969).

A study was conducted to compare the tissue absorption of x rays from two dental x ray machines, one operated at 50 kVp and the other at 90 kVp. It was found that 5.6 times more of the low-energy beam was absorbed within the cheek than was absorbed from the high-energy beam. This is consistent with calculations using the third power of the wavelength. (auth)

26800 EXPOSURE OF SOFT TISSUE AROUND BONE TO SOFT X RAYS. van Caneghem, P.; Mattelaer, G.; Dunjic, A.; VanHerle, R. (Univ., Liege). Hautarzt, 17: 359-63(Aug. 1966). (In German).

The radiation dose to soft and bony tissue was compared with scattered radiation from long-wave x irradiation (≤30 kV equivalent). The radiation dose received by bone from this type of radiation was less than in soft tissue. Stray irradiation was measured with a counter or ionization chamber. The irradiated object was enclosed in a Pb shield parallel to the radiation beam; a phantom and x-ray film were used for the measurements. The radiation was also measured by chemical dosimeters. Secondary radiation from S blocks ranged from 0.005 to 0.01 R/hr and from paraffin blocks 0.055 to 0.15 R/hr, measured with an ionization chamber. Secondary radiation from paraffin and rice was greater than with S blocks. Stray radiation intensity was greater on the surface of soft tissues as compared to bone probably because the Compton effect is greater in substances with smaller atomic number than substances with higher atomic number like S or bone. The photoelectric effect probably is more important in bone, where there is less scattering and low-energy fluorescence photons are produced. When a soft tissue located over bone, such as on the skull, is irradiated with low energy radiation, the effect is doubled because in this case not only the rear periosteum, but also the periosteum located between the bone and the radiation source was shown to be protected. (BBB)

26801 MEDICINE AND THE COMPUTER. IV. ASSISTING RADIOTHERAPY PLANNING. Brit. Med. J., 3: 180-1(July 20, 1968).

A computer program was written that enabled the rotation therapy dose at 361 chosen points in the body to be calculated, with an error of no more than ±1%, for each of the 36 field positions round the patient, and added up to produce the final dose distribution. The treatment indices are punched into cards, together with personal identifying details of the patient and data about the site and size of the tumor. The computer uses the card data, together with information about the treatment machine stored on magnetic tape, to calculate the dose distribution resulting from the specified plan. The accumulated doses for all 36 points are then printed out, and a contour map of dose distribution is also produced, that shows the percentage dose curves in relation to body and tumor outlines. (BBB)

26802 PRESENT STATE OF OCCUPATIONAL EXPOSURE TO IONIZING RADIATION. Liniecki, Julian; Jankowski, Jerzy (Inst. Medycyny Pracy, Lodz, Poland). Zdrow. Publiczne, 2: 205-11 (Feb. 1967). (In Polish).

According to official statistics of the Central Laboratory for Radioprotection and Public Health Service of Poland, there are about 3000 x-ray-equipped medical-scientific laboratories and 310 isotope-using medical-scientific laboratories in the country. The first group employs about 10,000 persons, mostly physicians, laboratory assistants and nurses, while the second employs about 3240 persons plus an additional 460 employees engaged in the special activities of handling radionuclides. Some 3000 persons are employed in industrial isotope installations, bringing the total number to over 16,000 employees occupationally exposed to ionizing radiation. This figure does not include workers who mine coal, metals, and pyrites, and who are frequently exposed to the effects of radiation by inhalation. Statistics show that the highest rate (about 1%) of exposure above the standard allowed yearly dose of 5 rem occurred among the employees of the group first, where 0.2% overexposure above the maximum 12 rem yearly dose was recorded. Next highest overexposure occurred as a result of 15 incidents involving stolen isotopes and consequent injuries suffered by 35 persons. Studies of radiation hazards stress the necessity of intensified educational campaigns in which factors relating to permissible doses, protective equipment, and safety procedures in handling, processing, storing, and transporting of radioactive materials are fully explained to all personnel concerned. (BBB)

26803 INTEGRAL DOSE IN 70-MM FLUOROGRAPHY OF THE GASTRODUODENAL TRACT. Carlsson, C.; Kaude, J. (Lund Univ., Sweden). Acta Radiol., Diagn. 7: 84-8(Jan. 1968).

The integral doses per film and patient were measured in a comparative clinical investigation with 70 mm fluorography and conventional roentgenography of the gastroduodenal tract. The total integral dose was 16.3 Kg rad, of which 10.4 Kg rad was from fluoroscopy, 5.1 Kg rad from 9 full-size roentgenograms, and about 0.8 Kg rad from ten 70-mm films. The integral dose per 70-mm film was 13% of that required for conventional radiography. Two 70-mm films were needed to obtain a record of the stomach with the patient standing. The integral dose for these 70-mm films was 23% of that obtained for one full-size roentgenogram of the stomach. The mean integral dose for a single 70-mm film was 12% of the integral dose for obtaining a full-size roentgenogram. The integral dose in a complete gastroduodenal examination was reduced on an average to 13% of that required in conventional radiography, i.e., by a reduction factor of 7.8 ± 1.4. The lower reduction in integral dose per patient was explained by a higher number of exposures that in some cases were necessary for filming of the stomach. When geometric magnification (enlargement factor approximately 1.8 to 1.9) was applied in 70-mm fluorography, the integral dose was reduced to 16%, or by a factor of 6.3 ± 1.3. (BBB)

26804 INTEGRAL DOSE IN 35-MM CINEFLUOROGRAPHY OF THE GASTROINTESTINAL TRACT. Kaude, J. (Lund Univ., Sweden). Acta Radiol., Diagn., 7: 170-5(Mar. 1968).

The integral doses were measured in 90 patients, in conjunction with a comparison of the diagnostic accuracy of 35-mm cinefluorography and full-size radiography of the gastroduodenal tract. The mean integral dose in complete cinefluorography of the gastroduodenal tract was found to be 14.9 Kg-rad (range 4.8 to 38.2 Kg-rad). The duration of cinefluorography averaged 1.5 min per examination (minimum 39 sec, maximum 3 min), and the integral dose rate 10 Kg-rad/min (minimum 2.1, maximum 24.2 Kg-rad/min). The integral doses in full-size radiography ranged from 1.4 to 9.0 Kg-rad, mean 3.7 Kg-rad. Between seven and 11 films (size 24 × 30 cm, and spot films) were usually obtained at each complete examination. The integral dose in a complete 35-mm cinefluorographic examination of the gastroduodenal tract was increased by a factor of about four compared with conventional radiography. (BBB)

26805 BASIC REASONS FOR ROENTGEN RADIATION PROTECTION. Jones, E. H. (Univ. of Sydney). Aust. Dent. J., 13: 260-4(Aug. 1968).

The biological effects of x rays, their measurement, effects on cells and on individuals are reviewed briefly and related to dental x-ray practice. Genetic effects of x rays are summarized and assessed as they apply to dental practice. A filtered dental x-ray machine operating at 65 kVp and 10 ma produces about 1 R/sec in air at the cone tip, with a 7- to 8-in. target film distance. If the output is unfiltered, then this dose may be more than doubled. Output at 90 kVp and 10 ma is about double that at 65 kVp. An acceptable dose from dental x rays would be 0.5 R of gonadal or whole-body radiation, as distinct from specific area radiation in the first 30 yr of life. Estimates of gonadal exposure to patients from dental x rays range from 0.001 to 0.0001 R for each R delivered to the skin of the face. Gonadal radiation is greater in children and less in women because of varying distance of the genetic organs from the x-ray source. Using the higher figure of 0.0001 R, 20 full mouth surveys could be taken over the 30-yr period with medium speed film and still remain within 0.5 R. Exposures can be reduced as much as 75% by use of ultra-speed film, electronic timers, long cone techniques, and by minimally adequate exposure times and full development in the dark-room. Draping the patient with a Pb apron will reduce gonadal exposure almost to the background level. The dentist should stand at least 5 ft behind the head of the x ray machine or at right angles to the direction of the x-ray beam. If this is impossible, he should stand behind a Pb-lined screen when taking roentgenograms. Machines should be inspected at regular intervals. (BBB)

26806 DOSE TO VARIOUS BODY ORGANS FROM INHALATION OR INGESTION OF SOLUBLE RADIONUCLIDES. Bunch, D. F. (Atomic Energy Commission, Idaho Falls, Idaho). pp

270-82 of Handbook of Laboratory Safety. Steere, Norman V. (ed.). Cleveland, The Chemical Rubber Co., 1967.

Mathematical and biological parameters of dose calculations are those recommended for the standard man by the ICRP. In order to establish more uniform practices in calculations, a computer program was written and estimates of dose were prepared for the isotopes and major organs listed in the ICRP reports. The estimates take the form of dose conversion factors such that a rapid and reasonable estimate of dose may be made. Dose conversion factors for thyroid, kidney, and skeleton are tabulated. (H.L.W.)

26807 ROENTGENOLOGICAL EVALUATIONS OF THE PELVIS IN OBSTETRICS. Hittmair, A. (Univ., Innsbruck). Wien. Med. Wochensch., 118: 126-9(Feb. 17, 1968). (In German).

The advantages of x-ray studies in obstetrical practice are discussed. In 240 lateral x-ray studies of the pelvis in pregnant women the average measured irradiation dose amounted to 62 mR. In order to keep the irradiation dose this low, an automatic exposure control was used with the x-ray equipment. The use of lateral views decreased the irradiation exposure of the embryo considerably, as compared to the x radiation exposure received when the sitting position was used. (BBB)

26808 AN ANALYSIS OF ^{60}Co ISODOSE PATTERNS FOR ECCENTRIC ROTATION WITH THE USE OF A DIGITAL COMPUTER. Onai, Yoshio; Tomaru, Teizo (Japanese Foundation for Cancer Research, Tokyo). Nippon Igaku Hoshasen Gakkai Zasshi, 28: 1379-95(Jan. 1969). (In Japanese).

Dose distributions in ^{60}Co planar rotation of 30-cm diameter circular and 20 × 30 cm oval phantoms, with the center of rotation at the center of the phantom were calculated with the use of a digital computer. A comparison of these was used to obtain the displacement of the center of rotation from the center of the phantom for the purpose of applying the isodose curves with centric rotation to those for eccentric rotation. In arc rotation of less than 300 degrees for a 30-cm diameter circular phantom, the isodose pattern for eccentric rotation becomes approximately the same as that for centric rotation. When the center of rotation is situated on the opposite side of the beam entrance, the isodose pattern becomes approximately the same as that for centric rotation with the oval phantom, whose major axis is taken as the arc bisector. If the displacement of the center of rotation from the center of the phantom is less than 4 cm, the differences in doses with and without displacement are less than 10 per cent for any angle of rotation. In the case of rotation for a 20 × 30 cm oval phantom, whose minor axis is taken as the arc bisector, the isodose pattern for eccentric rotation, whose center is situated on the minor axis between the center of the phantom and the entrance side of the beam, becomes approximately the same as that for centric rotation with more oblong phantom in shape. When the center of rotation is situated on the opposite side of the beam entrance, the isodose pattern becomes approximately the same as that obtained for centric rotation with the circular phantom. If the displacements for an oval phantom are less than 3 cm, the differences in doses with and without displacement are less than 10 per cent for any angle of rotation. When the center of rotation is located on the entrance side of the beam on the major axis of the oval phantom, taking the major axis as the arc bisector, the isodose pattern for eccentric rotation of less than 300 degrees becomes approximately the same as that for centric rotation with a circular phantom. In 360-degree eccentric rotation, the isodose pattern remains the same as that for the oval phantom without displacement. If the displacements are less than 6 cm, the isodose curves for the circular phantom without displacement would be applicable to those for eccentric rotation of the oval phantom with any angle of rotation in practice. (TSS) (NSAJ)

Radiation Protection

Refer also to abstracts 26412, 26552, 26602, 26816, 28069, 28076, and 28526.

26809 (RMC-UR-42) CONTROL OF RADIATION EXPOSURE IN URANIUM MINES: A COST AND ECONOMIC ANALYSIS. Spencer, N.; Spittel, L.; Towles, T.; Lady, G. (Resources Management Corp., Bethesda, Md.). Nov. 4, 1968. 66p.

The findings of a short-term study of the impact of uranium mining safety standards on the uranium producing and nuclear power industries are reported. The techniques by which the radon and radon-daughter concentrations in the mines can be reduced to successively lower levels were considered from a cost and effects standpoint. The feasibility of establishing a relation between the cost of contaminant reduction measures (in terms of dollars per ton produced uranium ore or per pound of its refined product, yellow cake) and the reduced level of contamination to be achieved were thoroughly considered. Some of the considerations necessary for an economic analysis of the effects of radiation contaminant control standards on the uranium mining industry, or nuclear electric power generation, and other sectors of the economy are discussed. Conclusions and recommendations of areas in which further study may be of value are also discussed. (C.O.)

26810 BODY BURDEN ASSAY SERVICES OF THE RADIATION PROTECTION DIVISION. Bird, P. M. (Dept. of National Health and Welfare, Ottawa). Amer. J. Public Health, 58: 2261-6(Dec. 1968).

The concepts underlying a body burden assay service and its relation to other activities of radiation protection are described. The primary objective is to provide an indicator of internal contamination with ^{14}C and ^{3}H, with secondary attention to other nuclides. Sampling regimes, methods, and standards for ^{3}H, ^{14}C, ^{226}Ra, and ^{238}U, were established. In those cases where test sensitivity permits, technical limits are lowered. Results were obtained for about 200 people. The pertinent information for the nuclides involved so far is summarized. Technical and medical limits are listed, but they are internal action numbers only. When the technical limit is exceeded, followup action includes repeat sampling to confirm initial findings, and whole-body counting if the contaminant is a γ emitter, as well as a detailed study to determine and correct the cause of the contamination. When the medical limit is exceeded, followup action also includes a review of the individual's medical and radiation dose records, cytogenetic studies, and medical and health recommendations. (BBB)

26811 EMC AND RADIATION HAZARDS. Hoffart, Henry M. (General Electric Co., Schenectady, N. Y.). Electro-Technol. (N. Y.), 82: 52-4(Nov. 1968).

Control of radiation hazards to the electromagnetic compatibility (EMC) engineers is considered. The electromagnetic interference (EMI) control engineer has the assignment of directing other engineers in reducing and containing the equipment's spurious electromagnetic energy generation and susceptibility characteristics. In addition, he subjects the designed equipment to tests in accordance with EMI specifications to validate the design and control criteria. The EMI control engineer, in assessing the electromagnetic environment to which the electronic equipment will be subjected, must also consider the effect to the electromagnetic environment on the operating personnel. The lack of sufficient attention to human radiation effects by the EMI control engineer is pointed out. For normal environmental conditions and for incident electromagnetic energy of frequencies from 10 MHz to 100 GHz, the radiation protection guide is 10 mW/cm^2 as averaged over any possible 0.1 hr period. This guide applies whether the radiation is continuous or intermittent. Thus, the standard radiation hazard warning in military electromagnetic interference specifications should be modified by adding a time limit on exposure. These limits, however, are still incomplete for radiation hazard purposes. Since everything in nature has resonance, the incident frequency must also be included as part of specified radiation exposure limits in order to identify the maximum radiation hazard areas. (BBB)

26812 A CONTRIBUTION TO RADIATION PROTECTION IN SMALL ANIMAL PRACTICE. RADIATION PROTECTION MEASUREMENTS. Hartung, K.; Clauss, W. (Freie Univ., Berlin). Berlin. Muenchen. Tieraerztl. Wochenschr., 80: 405-8(Nov. 1, 1967). (In German).

The international legal requirements and recommendations and the German laws and regulations pertaining to protection from radiation from x-ray equipment are discussed. Dosimetric measurements of fields of x irradiation scattered from equipment during thoracic and abdominal radiography were made, and isodose curves were constructed from the data obtained to estimate the radiation received by x-ray personnel. The results indicated that in small animal x-ray practice, using the apparatus and procedures described without protective clothing, from 25 to 100 radiographs/week could be taken without exceeding the permissible whole-body dose. However, if the extremities were exposed, only ~10 radiographs could be taken weekly. Exact shielding of the beam to conform to the cassette size was very important, because without proper masking stray radiation was increased considerably. Adequate attention also was given to wearing of a protective apron and gloves. (BBB)

26813 LASER LABORATORY DESIGN AND PERSONNEL PROTECTION FROM HIGH ENERGY LASERS. Goldman, Leon; Hornby, Peter; Rockwell, R. James. pp 294-301 of Handbook of Laboratory Safety. Steere, Norman V. (ed.). Cleveland, The Chemical Rubber Co., 1967.

Protection of personnel against high-energy laser systems is discussed with emphasis on eye and skin protection and inhalation hazards. Eye protection is divided into five phases, as follows: the design of laser systems to develop as much as possible the closed system technique; the avoidance of highly reflectant surfaces on and adjacent to the target areas; personnel protection in the form of protective devices for the eyes; constant reappraisal of all proposals for area and personnel protection; and continued eye examinations and records for all operating personnel. Inhalation hazards result from air contamination from the use of nitrogen coolants, nitrogen purges, and fragments from the laser plume. Raman laser spectroscopy and Brillouin scattering present hazards with laser impacts of such materials as benzene, nitrobenzene, toluene, and carbon disulfide. Factors involved in area control are avoidance of specular reflectance, protection from laser plume and air contamination, proper ventilation, and avoidance of electrical shock. (H.L.W.)

26814 HANDBOOK OF LABORATORY SAFETY. Steere, Norman V. (ed.). Cleveland, The Chemical Rubber Co., 1967. 579p.

Separate abstracts were prepared for five chapters of the book. Various aspects of laboratory safety are discussed, including protective equipment, ventilation, fire hazards, toxic hazards, and others. (H.L.W.)

For abstracts of individual chapters see: 26806, 26813, 26816, 26818, and 26819.

Safety Procedures

Refer also to abstract 26802.

26815 THE CLINIC OF NUCLEAR MEDICINE OF THE BERLIN RUDOLPH-VIRCHOW-HOSPITAL AS MODEL FOR AN OPTIMIZED BUILDING FOR RADIATION PROTECTION. Poelzig, Peter; Meyer, Hermann-Wolf; Chierego, Silvio; Hertling, Carl; Schumacher, Werner; Frost, Dietrich; Wuerthner, Klaus (Technical Univ., Berlin). Strahlentherapie, 136: 684-93(Dec. 1968). (In German).

At the Rudolf Virchow Hospital in Berlin, a new institute of nuclear medicine was erected. There are eighty beds age grouped in three wards. At the ground floor are grouped the diagnostic and therapeutic facilities. The construction and the radioprotection-measures allow now a higher number of treatments to be performed. Lack of space limited earlier the number of diagnostic-application. At the ground floor the circulation of patients is watched at an entrance. Visitors are admitted only to the third stage where betatron patients are housed. The ground floor is organized so that "hot" regions, with the radioactive treatment rooms, are as far away as possible from the entrance. The diagnostic application rooms are also under control. The first and second stages are also organized according to the activity involved: a region for very high and high activity, a controlled part; and a non-controlled part. In the third stage the betatron patients are housed. In the underground floor are grouped, except for general ancillary facilities, the stockage room for decay of radioactive waste and the total body counter. This floor is connected by a corridor with the röntgeninstitute and the betatron. (auth)

26816 SAFE HANDLING OF RADIOISOTOPES. pp 245-69 of Handbook of Laboratory Safety. Steere, Norman V. (ed.). Cleveland, The Chemical Rubber Co., 1967.

A discussion is presented of maximum permissible levels for exposure to external radiation and to radioactive contamination: safety organization; responsibility of the authority in charge of the installation; duties of the radiological health and safety officer; duties of the worker; medical supervision of workers; determination of radiation exposure of personnel; determination by personnel monitoring; determination by area monitoring; choice and design of sealed sources; methods of use of sources; shielding; general operations with unsealed sources; choice of radioactive material and suitable processes; choice and design of work places; protective clothing; personal protective measures; control of air contamination; special uses of unsealed sources; storage of sources; transportation of radioactive material; accidents involving radioactive contamination; decontamination of personnel; decontamination of equipment; and radioactive waste control and disposal. (H.L.W.)

Civil Defense

26817 (AD-674863) RADIOLOGICAL RECLAMATION PERFORMANCE SUMMARY. VOLUME II. EVALUATION AND CONDENSATION OF DATA FOR PREPLANNING OF RECOVERY OPERATIONS. Owen, W. Leigh; Cobbin, William C.; Shelberg, Wesley E. (Naval Radiological Defense Lab., San Francisco, Calif.). Sept. 26, 1967. 80p. (USNRDL-TR-68-71(Vol.2)). CFSTI.

A great deal of fallout reclamation-performance data has been generated over the past decade that is useful to planners of radiological recovery operations. Because it was contained in a variety of reports and documents prepared by different agencies, this material was neither convenient to Civil Defense planners nor was it always available in a useable form. As a first step toward correcting the situation, Volume 1 presented a tabular data compilation summarizing the performance of land reclamation methods and equipment. The tabled entries were gathered from 18 different experiments and field operations. They include those operational and environmental factors known to influence reclamation effectiveness. Volume II (contained herein) is devoted to the evaluation and reorganization of the above compilation into a form compatible with the preplanning of radiological recovery operations. The results are tabulated so as to show the response of various reclamation methods' performance to such parameters as rate of coverage, effort expended, climatic conditions, surface characteristics, and fallout properties. (auth) (TAB)

Legal Aspects

Refer also to abstract 26812.

26818 INTERNATIONAL ORGANIZATIONS PRODUCING NUCLEAR STANDARDS. Cottrell, William B. pp 288-93 of Handbook of Laboratory Safety. Steere, Norman V. (ed.). Cleveland, The Chemical Rubber Co., 1967.

A part of the second issue of the Compilation of National and International Nuclear Standards is reprinted. A table showing the standard organization of a number of international organizations, such as CERN, EURATOM, and IAEA, is presented. A legal notice concerning liabilities with respect to the use of, or for damages resulting from the use of apparatus or methods disclosed in the report is included. (H.L.W.)

26819 LIMITS FOR RADIOACTIVE SURFACE CONTAMINATION. Klein, H. F.; Schmidt, G. D. pp 283-7 of Handbook of Laboratory Safety. Steere, Norman V. (ed.). Cleveland, The Chemical Rubber Co., 1967.

A compilation of recommended guides for radioactive surface contamination and limits used by U. S. Government organizations, private organizations, and governments of other countries is presented. Surface contamination limits given for use in occupational areas and in non-controlled areas are applicable to skin, clothing, equipment, and other surfaces; e.g., floors and benches. Tables are presented of surface contamination guides for occupational exposure and for release to non-controlled areas. From the available data it appears that the surface contamination limits in use in the United States are conservative and have been effective in minimizing radiation exposure. (H.L.W.)

Medicine

Refer also to abstract 26508.

26820 (NP-16780(Vol.3)) A BIBLIOGRAPHY OF ONCOLOGY (CROSS BIBLIOGRAPHY OF PAPERS COLLECTION). VOLUME III. ISOTOPES, RADIOBIOLOGY, RADIOTHERAPY, CHEMIOTHERAPY, SURGERY, BIOLOGICAL INVESTIGATIONS. Review Report No. 31. Skurzak, H.; Rybarska, M.; Gadek, A.; Jasinski, W. (Instytut Onkologii, Warsaw (Poland)). 1968. 337p. (In Polish and English). Dep.

A list of 1500 papers is given in this third volume of a bibliography on oncology. Fields of interest covered are isotopes, radiobiology, radiotherapy, chemotherapy, surgery, and biological investigations. Both an author and subject indexes are provided. (C.O.)

Protective Substances

Refer also to abstracts 26697, 26764, 26858, 26880, 26957, 26967, and 26968.

26821 (YALE-3960-1) CATECHOLAMINE METABOLISM FOLLOWING X-IRRADIATION OF MAMMALS. Technical Progress Report, February 1969. [Van Woert, Melvin H.] (Yale Univ., New Haven, Conn. School of Medicine). Feb. 12, 1969. Contract AT(30-1)-3960. 7p. Dep. CFSTI.

Tritium-labeled norepinephrine was used to study the effects of x radiation on norepinephrine metabolism in rats. Endogenous levels of norepinephrine were first measured in the adrenal glands, heart, and spleen, via uptake of ^{3}H-norepinephrine. Levels of endogenous epinephrine were increased 25% at 24 hours and 35% at 48 hours after exposure to 1800 R doses. Results indicated that x irradiation had little immediate effect on the metabolism of norepinephrine, but at 48 to 72 hr following exposure, the rate of norepinephrine synthesis in the adrenals exceeded the rate of secretion. Mechanisms involved in the radioprotective action of pyrocatechol and serotonin were investigated in mice given specific inhibitors of pyrocatechol and serotonin synthesis prior to exposure. Both p-chlorophenylalanine (p-CPA) and α-methyl-p-tyrosine (α-MT) reduced the content of pyrocatechol and serotonin following injection into mice. However, p-CPA and α-MT, given singly or together, had a marked radioprotective effect on survival of x-irradiated mice. Dopamine protected against chain breaks in calf thymus, DNA x-irradiated (11,000 R/min) to total doses of 50 to 200 kR. Possible relations between this finding and mechanisms of the radioprotective effect of dopamine on mammals are discussed. (C.H.)

26822 ROLE PLAYED BY ENDOGENOUS SEROTONIN IN THE RADIOPROTECTIVE ACTION OF AMINOTHIOLS. Goncharenko, E. N.; Kudryashov, Yu. B.; Alieva, L. I. (Inst. of Higher Nervous Activity and Neurophysiology, Moscow. Moscow State Univ.). Dokl. Akad. Nauk SSSR, 184: 1437-8(Feb. 21, 1969). (In Russian).

The content of Serotonins in tissues of animals treated with radioprotectors (aminothiol) was studied using white male rats (weighing 120 to 130 g) treated intraperitoneally with aqueous solutions of aminothiols and exposed to whole-body irradiation with 50 rad/min. Tabulated data showed that not only general but also biologically active Serotonin increased considerably in the tissues of small intestine and stomach after injection of AET, cystaphase, cysteamine, and cystamine. Treatment with cysteine which has a lower radioprotective property resulted in accumulation of only general Serotonin, without its free fraction. It was concluded that the radioprotective effects of aminothiols are reflected in the concentration of Serotonin in radiosensitive organs of animals. (R.V.J.)

26823 INHIBITION OF CATALASE AND LACTATE DEHYDROGENASE BY RADIATION-PROTECTIVE THIOLS AND THIOL DERIVATIVES. Foye, William O.; Solis, Maria C. M. (Massachusetts Coll. of Pharmacy, Boston). J. Pharm. Sci., 58: 352-5(Mar. 1969).

A series of amino and guanidino thiols and thiol derivatives has shown a parallelism between their radiation-protective abilities in mice and their ability to inhibit the metalloenzyme catalase. Exceptions were found with a dithiocarbamate, which has higher metal-binding strength than the thiols, and a thiosulfate, which has weaker metal-binding ability. Inhibition of two forms of lactate dehydrogenase, where metal binding is unlikely, showed no correlation with radiation protection. This suggests that protection of catalase from radiation damage by agents that complex with the iron constituent constitutes one means of protecting animal cells from radiation-produced peroxides. (auth)

26824 RADIATION-PROTECTIVE AGENTS IN MAMMALS. Foye, William O. (Massachusetts Coll. of Pharmacy, Boston). J. Pharm. Sci., 58: 283-300(Mar. 1969).

The protective effect of chemicals against the damaging action of ionizing radiation was first noted by Dale. A decrease in the inactivation of two enzymes by x rays was brought about by the addition of several substances, including colloidal sulfur and thiourea, to aqueous solutions of the enzymes. Since then, radiation protection has been observed in a variety of animal and plant cells by a surprising number of compounds, albeit of relatively few chemical or pharmacological classifications. Radioprotection of a bacteriophage was noted in 1948 by Latarjet and Ephrati, using thioglycolic acid, glutathione, tryptophan, cysteine, and cystine. Radioprotection of mice was achieved shortly after by means of cyanide, cysteine, and thiourea, these protective effects being attributed at the time to inhibition of, or reaction with, cellular enzymes. The importance of an amino group for the radioprotective action of a mercaptan was first shown by Bacq, who removed the carboxyl group of cysteine in order to liberate the basic function; this resulted in the important discovery of cysteamine (β-mercaptoethylamine), still regarded as one of the most potent of the radioprotective agents. Since 1952, other types of structures have been found with radioprotective effects, including a number of commonly used pharmacological agents, but the most effective have generally been derivatives or analogs of the aminoalkyl mercaptans. Present research attempts have been more concerned with the explanation of radioprotection in the cells than the discovery of new protective agents, and a number of plausible explanations have been put forward. No wholly convincing evidence for any of the major postulated mechanisms of radioprotection has yet been described, but some cellular events appear quite reasonable in regard to the protection afforded by several of the more highly investigated compounds. This review attempts to list the various types of chemical structures for which some protection against the deleterious effects of ionizing radiation in mammals has been found. Detailed discussions of the action of the more widely accepted radiation-protective agents appear elsewhere; the purpose here is to catalog those structures with protective activity and describe the more widely considered mechanisms of protection by which they may act. (auth)

26825 RADIOPROTECTIVE COMPOSITIONS CONTAINING CYSTEAMINE DERIVATIVES. Reynolds, Delbert Daniel; Fields, Donald Lee (to Eastman Kodak Co.). British Patent 1,141,749. Jan. 29, 1969. Filed Apr. 28, 1967.

A study was made of the effects on the anti-radiation effectiveness of alkyl substitution on the amine group in 2-aminoethanethiol. Results show that the most effective compounds were those with N-n-alkyl substituents having 8, 9, or 10 carbon atoms. The dose reduction factor of the N-n-alkyl-2-aminoethanethiol were not appreciably different from that of 2-aminoethanethiol; however, they possess an outstanding advantage in that the maximum safe dose is much higher than that required for anti-radiation activity. The presence of the normal alkyl group of 8 to 10 carbon atoms produces a striking reduction in the convulsive activity, which is one of the most serious shortcomings encountered with 2-aminoethanethiol. (D.H.M.)

26826 MECHANISMS OF ACTION OF RADIOTHERAPY AND CHEMOTHERAPEUTIC ADJUVANTS. Vermund, H.; Gollin, F. F. (Univ. of Wisconsin, Madison). Wis. Med. J., 67: 328 (July 1968).

Molecules of DNA as the unique, irreplaceable and therefore important target for the ionizing radiation events are considered in terms of mechanisms of radiotherapy and chemotherapeutic adjuncts. Almost all of the chemotherapeutic agents with antitumor activity also interfere with nucleic acid metabolism, by either directly combining with and altering the DNA molecules (e.g., alkylating agents, actinomycins, IUDR, 6-thioguanine) or blocking metabolic pathways for their synthesis (the halogenated pyrimidines, 6-mercaptopurine, actinomycins, methotrexate). Mechanisms of radiosensitizers in some instances appear to involve the initial physical—chemical events, resulting in the formation of radicals in greater numbers or with longer half-lives; in other instances they involve modifications of the vulnerable cellular targets. In all probability the DNA molecules represent the most important targets for both radiation and the sensitizing chemicals. Therapeutic compounds interfere with mechanisms of repair of sublethal radiation damage. The extent of such repair can be evaluated by a study of the dose-survival curves after fractionation of the radiation dose. The mechanism of cell number reduction must also be considered. The role of enzyme deficiency in radiosensitization of malignant cells and the cytolethal effects of some antitumor agents are discussed. (F.F.M.)

26827 COMBINATION OF 5-FLUOROURACIL AND RADIATION AS PRIMARY THERAPY OF CARCINOMA OF THE CERVIX. **Goolsby, Charles D.; Daly, James W.; Skinner, Odis D.; Gibbs, Charles E. (Wilford Hall USAF Hospital, Lackland Air Force Base, Tex.). Obstet. Gynecol., 32: 674-6(Nov. 1968).**

Possibility of antitumor synergistic effects of 5-fluorouracil (5-FU) and 250 kV x rays or ^{60}Co γ rays in 22 cervical carcinoma patients was investigated. The 5-FU, 15 mg/Kg, was given daily for 4 or 5 days in 500 ml of 5% glucose solution (the daily dose never exceeded 1000 mg). It was administered for about two hr before external radiation was given, during radiotherapy, and for about two hr after. The dose of external radiotherapy was 4000 to 5000 RAD tumor dose. Radium applications generally were done at the end of the external therapy; the dose varied between 4000 and 6000 mg-hr, in one or two applications. The total number of patients that had toxic manifestations from the drug was 17 of the 22 treated. There was one each of the following complications caused by irradiation: bladder ulcer, vaginal ulcer, rectal stenosis, rectovaginal fistula, and radiation fibrosis of terminal ileum. The complications caused by radiation were not excessive and could have been expected, even without the chemotherapy. Although in certain patients the response to therapy seemed to indicate a more rapid shrinkage in tumor bulk, the over-all results were not better than could be expected with radiotherapy alone. It was concluded that the combination of 5-FU and radiotherapy, as used here, was no more effective than radiation alone in the therapy of cervical cancer. (BBB)

Radiation Sickness and Injuries

26828 CHARACTERISTICS OF CALLUS FORMATION IN FRESH CRUSHED FRACTURES OR FRACTURES WITH A DEFECT ACCOMPANIED BY RADIATION SICKNESS (400 r) UPON APPLICATION OF BONE HOMOTRANSPLANTATION AND INTERMEDULLARY METAL SYNTHESIS. Turturikov, L.; Nakov, E. Voenno-Med. Delo, 23: No. 4, 11-16(Aug. 1968). (In Bulgarian).

Fresh crushed bone fractures or fractures with a defect produced in rabbits that were irradiated with a dose of 400 R of x rays were treated by homotransplantation of fragments of tubular bone preserved at −25°C combined with intramedullary metal synthesis to support the transplanted fragments. Formation of the bone callus in irradiated animals proceeded satisfactorily. The results indicated that no contraindications exist to the treatment of bone fractures by homotransplantation in the latent period of radiation sickness; this treatment is desirable. Use of bone fragments preserved at −25°C expedited healing. (JPRS)

26829 THE INFLUENCE OF CLINICAL DEXTRAN AND MODIFIED GELATIN ON HEMORRHAGIC DIATHESIS IN IRRADIATED, THROMBOCYTOPENIC DOGS. Kummer, H.; Lundsgaard-Hansen, P. (Inselspital, Bern). Helv. Med. Acta, 34: 244-54(July 1968).

Dextrans may have adverse effects on hemostasis, which increase with the molecular weight and the dose of the preparation administered. Since plasma substitutes are widely stockpiled for use in the case of possible major wars, when casualties with radiation damage must be expected, objective evidence on the influence of clinical dextran and modified fluid gelatin on hemorrhagic diathesis in postirradiation thrombocytopenia would be desirable. The results of such a comparative study are presented, hemorrhagic diathesis being monitored by the erythrocyte output in thoracic duct lymph. Dogs received 250 to 385 R whole-body doses of ^{60}Co irradiation and the influence of clinical dextran and modified gelatin on the erythrocyte output in the lymph of the thoracic duct was investigated in the thrombocytopenic animals. A standardized phlebotomy of 25 ml/Kg body wt was followed by a rapid infusion of 15 ml/Kg body wt of either clinical dextran or modified fluid gelatin. The erythrocyte output in the thoracic duct lymph increased by a significant amount in four of six dogs treated with clinical dextran, whereas modified fluid gelatin had no effect on the erythrocyte output in the lymph in an otherwise comparable group of six animals. Implications for the medico-military use of plasma substitutes under the conditions of nuclear warfare are mentioned. (BBB)

Radiodiagnosis

Refer also to abstracts 26451, 26655, 26684, 26704, 26790, 26803–26805, 26807, 26929, 26933, 26936–26938, 26940, 26941, and 26954.

26830 (UCLA-12-706) SEMIANNUAL PROGRESS REPORT FOR THE PERIOD ENDING DECEMBER 31, 1968. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology). Contract AT(04-1)-Gen-12. 90p. Dep. CFSTI.

Separate abstracts were prepared for five sections of this report. Various aspects of radiobiology, nuclear medicine, and environmental radiation are included. (H.L.W.)

For abstracts of individual sections see: 26642, 26664, 26687, 26712, and 26831.

26831 (UCLA-12-706, pp 1-24) NUCLEAR MEDICINE. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology).

Radioactive tantalum prepared by neutron activation was administered to dogs by inhalation for studies on clearance patterns and long term retention within the lung parenchyma. Variations in particle size, shape, hardness and quantity of radioactive macroaggregates of albumin were determined for studies on coronary blood flow. Regional ventilation following experimental pulmonary emboli before and during administration of serotonin was studied. Radioaerosol inhalation scans showed no definite changes in ventilation produced by serotonin injections. Lung scintigraphy using ^{99}Tc was used for studies on regional alveolar liquid diffusibility. Endothelial lesions were demonstrated by scintiscanning following injection of albumin macroaggregates labeled with ^{99}Tc. A sulfur suspension labeled with ^{99}Tc was used for scanning of bone marrow, liver, and spleen. The Total Body Counter was used for measurements of plasma turnover of immune globulins labeled with ^{125}I and ^{131}I in patients with rheumatic diseases and for measurements of total body absorption and retention of ^{67}Cu in patients with disorders of iron metabolism. A method of labeling aggregated particles of human serum albumin with ^{113}In was developed. In cultures of brain tumor tissues a greater amount of ^{99}Tc-pertechnetate was incorporated into tumor cells than into nonneoplastic cells. Other studies included assessment of cerebrovascular disease by the scintillation camera; quantification of the scintillation camera; combined inhalation-perfusion scanning and pulmonary function studies in chronic obstructive airway disease; effects of remnant and whole organ grafts of thymus in the recovery of thymectomized irradiated mice; and effects of 6-mercaptopurine imuran and antilymphocytic serum on the development of mouse lymphoma. (H.L.W.)

26832 SCREENING FOR KIDNEY DISEASE WITH RADIOISOTOPES. Nordyke, Robert A.; Gilbert, Fred I. Jr.; Simmons, E. Lee (Straub Clinic, Honolulu, Hawaii). J. Amer. Med. Ass., 208: 493-6(Apr. 21, 1969).

Screening for unilateral kidney disease has been simplified by the use of radioisotopes. Renography is nearly ideal for searching through large groups of patients to find the relatively few with important lesions. Among categories of patients effectively screened are those with hypertension and those with abdominal or back pain. A study of apparently well men suggests that renography may be an important addition to the routine medical checkup. Renal scanning and renography used together are more effective in finding disease than either alone. However, present radiation levels require that the scan be used on a selective basis. Faster scanning and isotopes with shorter half-life will soon allow consideration of the combination for screening on a more widespread basis. (auth)

26833 USE OF THE SCINTILLATION ANGER CAMERA AND XENON ^{133}Xe IN THE STUDY OF CHRONIC OBSTRUCTIVE LUNG DISEASE. Medina, Jose R.; Lillehei, James P.; Loken, Merle K.; Ebert, Richard V. (Univ. of Minnesota, Minneapolis). J. Amer. Med. Ass., 208: 985-91(May 12, 1969).

Pulmonary ventilation and perfusion were studied in 12 normal subjects and 40 patients with obstructive lung disease. Xenon-133 and the scintillation Anger camera were used. Serial photographs were obtained after injection, inhalation, and washout of ^{133}Xe. The distribution of blood flow and ventilation was studied in these photographs. Normal subjects presented uniform distribution of perfusion and ventilation. Preferential blood flow to the bases was noted because the patients were in the upright position. Patients with severe, chronic, obstructive lung disease showed regions of poor ventilation with or without areas of impaired perfusion. The scintiphotographs were found to be a valuable addition to the study of regional lung function, since they permit identification and mapping of areas of impaired perfusion or of poor ventilation. (auth)

26834 HUMAN CHORIONIC THYROTROPIN: FURTHER CHARACTERIZATION AND STUDY OF ITS SECRETION DURING PREGNANCY. Hennen, G.; Pierce, J. G.; Freychet, P. (Univ., Liege. Univ. of California, Los Angeles. Institut National de la Sante et de la Recherche Medicale, Paris). J. Clin. Endocrinol. Metab., 29: 581-94(Apr. 1969).

The partial purification and immunological characterization of the human chorionic thyrotropin (HCT) was described. The behavior of the chorionic factor during the steps of purification was similar to that of pituitary thyrotropin (TSH) although its chromatographic and electrophoretic properties suggested that HCT was less acidic than the human pituitary hormone. The specific activity of the most purified fraction was 3500 times that of the starting extract. Double diffusion experiments showed the extent of immunological cross-reactivity of HCT with human pituitary thyrotropin to be low, in confirmation of earlier results, but a close immunological relationship between the chorionic factor, bovine, and porcine TSH was found when both were reacted against highly specific antibovine or antiporcine TSH serum. This rather surprising difference in the degree of cross-reactivity between HCT with human compared to that with porcine and bovine TSH was confirmed by experiments on the neutralization of biological activity and by radioimmunological studies: HCT interfered very poorly in a ^{131}I-human TSH-antihuman TSH antibody system, while it strongly inhibited the binding of labeled bovine TSH to antibovine or to antiporcine TSH antibody; HCT also inhibited the binding of labeled human TSH to antiporcine TSH antibody. The circulating thyroid-stimulating activity in pregnant women was found significantly higher than in serum of nonpregnant women, and particularly at the beginning of gestation. Radioimmunoassay of pregnancy serum extracts with high thyroid-stimulating activity gave results fitting in with the behavior of HCT in the ^{131}I-human TSH-antihuman TSH as well as in the ^{131}I-human TSH-antiporcine TSH systems. It was thus suggested that HCT is actually secreted during pregnancy and responsible for the high thyroid stimulating activity of pregnancy serum. (auth)

26835 STUDY OF PARATHYROID FUNCTION IN MAN BY DTA INFUSION. Parfitt, A. M. (Univ. of Queensland, Brisbane). J. Clin. Endocrinol. Metab., 29: 569-80(Apr. 1969).

The response to a two-hr infusion of Na$_3$ EDTA was studied in two normals, four patients with pseudohypoparathyroidism and 15 patients who had undergone neck surgery, 11 with subsequent temporary hypocalcemia and 4 without. To establish non-arbitrary criteria of interpretation, these 21 cases and 129 others reported, were divided into three groups according to their status before the test: 64 normals, 57 without prior evidence of parathyroid dysfunction other than treatment for hyperthyroidism, and 29 with prior evidence of parathyroid dysfunction. The mean values of unchelated plasma calcium corrected to a preinfusion level of 10.0 mg/100 ml showed significant ($p < 0.001$) differences between the groups at 10 hr (C_{10}) and between the groups at 22 hr (C_{22}) after the end of the infusion (Time 0). Based on these results, three grades of response were defined, according to which the 21 cases in the present study were reclassified: grade 0 (normal) $-C_{22}$ and C_{10} both ≥ 9.5 mg/100 ml (5/21 cases), grade 1 $- C_{22} \geq 9.5$ mg/100 ml $> C_{10}$ (10/21 cases), and grade 2 $- C_{22}$ and C_{10} both <9.5 mg/100 ml (6/21 cases). The different rates of recovery in these three grades did not depend on differences in plasma phosphate or magnesium before or during the test or on intestinal absorption or tubular reabsorption of calcium; they reflect degrees of parathyroid insufficiency rather than degrees of adaptation to the aparathyroid state. Comparison of the results with predictions from a 3-compartment kinetic model of the exchangeable calcium pool suggests that mobilization of calcium from the non-exchangeable pool in bone normally begins at two hr and is maximal and almost complete at 10 hr; in subjects with a grade 1 response this process is delayed for four hr and prolonged by 12 hr, and in those with a grade 2 response it is absent, partial recovery resulting purely from passive rearrangement of the calcium remaining in the rapidly exchangeable pool. (auth)

26836 A METHOD FOR THE ELIMINATION OF MAGNIFICATION IN ROENTGENOGRAMS FOR SCINTISCAN SUPERIMPOSITION. **Lewall, David B.; Tauxe, Newlong W. (Mayo Clinic, Rochester, Minn.). Amer. J. Clin. Pathol., 48: 568-72(Dec. 1967).**

A method of obtaining relatively unmagnified roentgenograms is described and discussed. A moving x-ray beam collimated at the level of the film is used to radiograph the part of the body under study. Because the effective part of the x-ray beam is always perpendicular to the plane of the film, magnification is virtually eliminated. This method has increased the reliability of scans of the brain, heart, lungs, and liver. The more precise boundaries in two dimensions provided by the modified slit scanogram increase diagnostic precision. The roentgenographic detail obtained is not as good as that provided by conventional roentgenograms and the lower edge of the liver is frequently not depicted, but diaphragmatic and lateral borders are clearly established. Preliminary experience indicates that its use has increased not only the incidence of positive scans but has also increased the reliability of negative scans. The technique is low in cost and the apparatus required is simple. The basic equipment may be easily and inexpensively modified, without hindering the use of the equipment for routine roentgenographic work. The technique should have other applications, such as the precise localization of foreign bodies in the eye and simplified roentgenographic pelvimetry. The tissue dose is about the same as the dose for conventional radiography. (BBB)

26837 USE OF BRAIN SCANNING FOR EVALUATION OF THE MENTALLY DISTURBED PATIENT. **Briggs, Russell C.; Steffen, Dennis H. (Univ. Hospitals, Madison, Wis.). Wis. Med. J., 66: 507-9(Oct. 1967).**

The use of ^{99m}Tc for brain scanning as a rapid diagnostic method for screening of three psychiatric patients for the presence of intracranial tumor is discussed. There were no consistent or specific neurologic patterns. Neoplasms were found in three distinctly different sites: frontal, intraventricular, and occipital. In the three cases presented the scans indicated abnormalities. Brain scanning with ^{99m}Tc is most accurate in meningiomas and glioblastomas. Metastatic tumors and neopiasms with low histological grading are somewhat more difficult to visualize. The scan defined both the site and size of the lesion. The accuracy with ^{99m}Tc has been reported to range from 70 to more than 90%. Statistics on the proportion of psychiatric patients having positive ^{99m}Tc brain scans were not available. It was concluded that further study of this point might result in an increased salvage of patients with apparent or real mental illness. (BBB)

26838 INVESTIGATIONS CONCERNING THE RESOLUTION OF A 5''-NaI-CRYSTAL DETECTOR IN SCINTILLATION SCANNING. **Kutzner, Joachim (Central Army Hospital, Koblenz, Ger.). Strahlentherapie, 136: 675-83(Dec. 1968). (In German).**

Comparative measurements were done at scintillators scanner equipped with a crystal of 5" × 2", 3" × 3" and 3" × 2" and for different collimators. Cold and hot nodules of 10 mm diameter could well be demonstrated in a thyroid phantom, whereas 15 mm defects at a depth of 7 cm in water, could be visualized in a kidney model. The results and its pratical consequences are outlined. (auth)

26839 DETERMINATION OF THE GLOMERULUS FILTRATE IN DECREASING ^{51}Cr EDTA PLASMA LEVELS. **Pixberg, Hans-Ulrich (Medical Coll., Hanover). Strahlentherapie, 136: 700-4 (Dec. 1968). (In German).**

A comparison in 35 patients of the ^{51}Cr-EDTA clearance with the endogenous creatinine clearance showed a good correlation. In some cases deviations are observed, but this does hardly limit the method as screening test. Correct determinations of the glomerular filtration is however not possible. The advantage of the method lies in its simplicity and in the fact that precise urine collections are not necessary. (auth)

26840 EXTERNAL COUNTING OF ^{85}Sr IN BONE AND JOINT TUBERCULOSIS. Kettunen, Kauko; Rekonen, Ahti (Central Hospital, Kuopio, Finland). Ann. Chir. Gynaecol. Fenn., 57: 250-6(1968).

The uptake of ^{85}Sr in active, nonactive, and recidivating bone or joint tuberculosis, and the effect of therapy on radioisotope uptake are reported. A dose of 50 μCi of ^{85}Sr was administered intravenously. The measurements were made a week after the injection. The main disadvantage of the method is nonspecificity. Various local bone processes such as malignant tumors, fractures, and infections cause an increase in the uptake. This makes it impossible to establish by external counting which particular process is causing the increase in uptake. Some benign, noninflammatory bone processes such as degenerative spondylosis, spondylotic changes due to scoliosis, juvenile spinal osteochondrosis, and congenital block vertebra also cause increased uptake of the isotope. The increase in uptake is relatively small and easily distinguishable from an increase caused by active TB. It may be extremely difficult to differentiate between juvenile spinal osteochondrosis and incipient TB spondylitis. External counting may be used in the differential diagnosis of active tuberculosis spondylitis and juvenile osteochondrosis. Osteoarthritis and rheumatoid arthritis cause an elevated isotope uptake in the articular region. Tuberculosis-induced joint changes also stimulate calcium kinetics which is manifested as an increase in uptake. This makes diagnosis of recurrences of joint TB and arthritic joint changes difficult. (BBB)

26841 SIGNIFICANCE OF SCINTIGRAPHY FOR DIAGNOSIS OF RENAL TUBERCULOSIS. Schmidt, K.-J.; Pierach, C. A.; Wolf, R. (Univ., Mainz). Fortschr. Geb. Roentgenstr. Nuklearmed., 109: 733-40(Dec. 1968). (In German).

Thirty-six patients with bacteriologically confirmed renal tuberculosis were examined by radioisotope scanning following the administration of ^{99}Tc-labeled Fe complexes. Scintigraphy affords certain advantages compared with conventional arteriography; in addition to morphological information, it provides some functional assessment, particularly through comparison of the two sides. It was shown that certain criteria may provide suspicion of renal tuberculosis at an earlier stage when scintigraphy is employed, than is possible by radiological investigations. At a more advanced stage, the findings from conventional radiology and scintigraphy supplement each other. The shrunken tuberculous kidney cannot be clearly demonstrated by an excretion urogram, whereas an accurate picture of its size and shape may be obtained by scintigraphy. This may further indicate the amount of functional parenchyma when an urogram has failed. It is therefore an important preoperative aid in diagnosis. Renal scintigraphy appears particularly suitable for serial observations, since it is easy for the patient, does not result in reactions such as may occur after radiography using contrast medium, and produces only a small amount of radiation. (auth)

26842 SCINTILLATION CAMERA RENOGRAPHY IN SUPERIOR INFUNDIBULAR OBSTRUCTION. **Harbert, John C.; Fraley, Elwin E. (National Cancer Inst., Bethesda, Md.). J. Amer. Med. Ass., 207: 2433-4(Mar. 31, 1969).**

Five patients with superior infundibular obstruction were studied with scintillation camera renography and ^{197}Hg. The renogram tracings in all patients showed prolonged transit time and flattening of the excretory phase. The scintiphotos accurately localized the site of tracer retention to the superior collecting system of the involved kidney. (auth)

26843 METHOD OF LOCALIZATION OF THE PLACENTA BY MEANS OF ENDOVENOUS INJECTION OF RADIOIODINATED SERUMALBUMIN AND LINEAR SCANNING. **Colombo, L.; Conte, L.; Seassaro, E. (Univ., Milan). Radiol. Med., 55: 132-43(Feb. 1969). (In Italian).**

A method that permits a rapid, easy, and reliable indication of the placenta site by the use of linear scanning is described. Human radioiodinated (^{131}I) serum albumin was used because its characteristics permitted evidence of a much vascularized organ with relative simplicity. The radiation dose absorbed by the mother and by the fetus employing 20 to 30 μCi of tracer was estimated; this activity appeared to be necessary with the elaborated method. The method was verified on a group of pregnant patients researching, when the opportunity occurred, the correspondence between the radioisotopic localization and the anatomic one. (auth)

26844 POSSIBILITY TO ESTIMATE LIVER BLOOD FLOW BY MEANS OF COLLOIDAL HUMAN ALBUMIN–^{131}I (CA^{131}I). Bergonzi, M.; Riccardi, A.; Ferrari, G. P. (Univ., Milan). Med. Nucl.-Radiobiol. Lat., 11: 1-19(1968). (In Italian).

A method is described for measuring liver blood flow by external scanning following the injection of ^{131}I-labeled colloids of human serum albumin. The use of colloids of serum albumin gave better results than those obtained using labeled serum albumin. (C.H.)

26845 METHOD FOR MEASUREMENT OF REGIONAL BLOOD FLOW WITH RADIOACTIVELY LABELED PARTICLES. Flohr, H. (Univ., Mainz). Pfluegers Arch.-Eur. J. Physiol., 302: 268-74(1968). (In German).

Blood flow distribution within the systemic circulation was studied by the distribution of ^{131}I-labeled macroaggregates after infusion into the left ventricle of cats and rabbits. The particles used had a diameter of from 5 to 50 μ. There was a recirculation of about 2 or 3%. The peripheral distributions in brain, heart, kidney, liver, spleen, and lungs were 3.4, 8.4, 11.5, 4.8, 1.0, and 3.2% of injected dose, respectively. Cardiac output, arterial pressures, and total peripheral resistance were unchanged during and after the infusions. The principles of the method and the possible sources of error are discussed. (BBB)

26846 SJOEGREN'S SYNDROME: ADDITIONAL DIAGNOSTIC TOOLS. Abramson, Allan L.; Goodman, Merrill; Kolodny, Howard (Long Island Jewish Hospital, New Hyde Park, N. Y.). Arch. Otolaryngol., 88: 91-4(July 1968).

The use of ^{99m}Tc for salivary gland scintiscanning in the diagnosis of Sjogren's syndrome is described. In this procedure 1 μCi of ^{99m}Tc was injected intravenously into the antecubital fossa and photoscans of the lateral neck-face areas were made using a scintillation detector with a 31-hole fine focus Pb collimator 30 to 60 min later. Salivary glands actively concentrated and secreted ^{99m}Tc-pertechnetate into the saliva causing a concentration 30 to 40 times that of plasma. The glands studied were unable to concentrate the ^{99m}Tc in normal individuals. (TSS) (BBB)

26847 ANALOG AND DIGITAL STORAGE OF RADIOISOTOPE INDICATOR CONCENTRATION DATA ON FM ANALOG MAGNETIC TAPE. Malindzak, George S. Jr.; Swonger, Kenneth D. (Wake Forest Univ., Winston-Salem, N. C.). Comput. Biomed. Res., 2: 160-3(1968).

A method is presented for simultaneous storage of the analog signal representing radioisotope indicator concentration data and its digital (BCD) equivalent on FM analog tape. The basic process involved the modification of a previous design which provided for multiplexing two data channels onto a single tape channel. (BBB)

26848 ^{99m}Tc-ALBUMIN FOR BRAIN SCANNING. Ashburn, William L.; Di Chiro, Giovanni; Briner, William H.; Harbert, John C. (National Inst. of Health, Bethesda, Md.). Drug Intel., 1: 314-16(Oct. 1967).

The advantages of ^{99m}Tc for brain scanning as based on the physical characteristics of the radioisotope and the biological behavior of the pharmaceutical agent are discussed. Advantages of ^{131}I-albumin and ^{99m}Tc are also compared. Albumin is a biologically favorable tumor-localizing agent. Because of the physical characteristics of ^{131}I (364 keV γ, β emission, and eight day half-life), ^{131}I-albumin was used as a brain scanning agent for many years with excellent results. The favorable physical features of ^{99m}Tc-pertechnetate and ^{99m}Tc-albumin make it superior to ^{131}I-albumin for brain scanning. It has also been used for placental localization and blood pool scanning. The biological properties of ^{99m}Tc-albumin are essentially identical to ^{131}I-albumin. Results from over 50 adult patients who received between 3 to 10 mCi of ^{99m}Tc-albumin are reported. The ideal scanning time appears to be between two to three hr after administration. Several patients were scanned as late as 22 hr when the maximum dose was given. (BBB)

26849 HEPATO-LAMINO-SCINTISCANNING. Maeda, Tomoho (Kobe Univ., Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 28: 1327-36(Jan. 1969). (In Japanese).

Although scintiscanning is a useful diagnostic method for hepatic diseases, the scintigram merely presents a projected pattern on a plane. So, with a scintigram, observation of a three dimensional distribution of radioisotopes is not possible. Besides, it is difficult to detect small tumors which are deeply situated in a dense organ like a liver. In order to obtain a stereographic effect and contrast accentuation of the small counting rate change on the scintigram, a new scintiscanning method called Laminoscintiscanning was developed. Two scintillation probes are arranged crossing at right angles at the foci of honeycomb type collimators, and pulses from both scintillation probes are fed into a multiplying circuit after pulse height analysis. The multiplying circuit consists of a magnetic field current controller and a semiconductor current controller. The laminoscintigram shows the section which is taken at the depth of focus of the detector. From the experimental and clinical application of laminoscintiscanning, the following results were obtained: Three dimensional understanding of organs was possible to a certain degree. By using the multiplying circuit, the contrast was more strongly amplified than with other scintiscanning methods. In experimental scanning on a liver phantom, it was possible to recognize a tumor of 1.5 cm in diameter situated at less than 5 cm in depth, and one of 3 cm in diameter at more than 7 cm in depth. In clinical applications, laminoscintiscanning can indicate the depth of tumors in the liver and can detect a deeply situated small cold area which cannot be recognized by ordinary area scintiscanning. Thus the morphological aspect of tumors in the liver can be accurately shown. (TSS) (auth)

26850 THE DIAGNOSIS OF BONE METASTASES IN UROLOGICAL CANCERS USING RADIOACTIVE ISOTOPES. Kolar, J.; Vyhnanek, L.; Bek, V.; Babicky, A.; Janko, L.; Drapelovau, D. (Charles Univ., Prague). Z. Urol., 60: 577-81(Aug. 1967). (In German).

The detection of bone metastases by means of ^{85}Sr was studied in 337 patients with urological tumors. The longest period of latency between a positive radioisotopically detectable metastasis and its detection by x ray was 11 months. The results of the radioisotopic tests were nonspecific, because other, entirely different pathological metabolic conditions, such as fractures, inflammations, Paget's disease, fibrotic bone dysplasia, Recklinghausen's disease, and progressive degenerative diseases caused increased uptake of ^{85}Sr similar to primary bone tumors or metastases. For this reason it was difficult to establish a correct diagnosis from the ^{85}Sr tests alone without x-ray studies. (BBB)

26851 HEPATIC SCINTILLOGRAPHY. Czerniak, P. (Government Hospital, Tel-Hashomer, Israel). Dapim Refuiim, 26: 3-16(Sept. 1967). (In Hebrew).

The results of liver scintigraphy with ^{198}Au and ^{131}I-labeled rose bengal were reported for more than 2000 patients, aged from 2 weeks to 82 yr. Evaluation of results obtained from the anterior-posterior view showed a correlation of 70 to 75% with pathological findings. By scanning in 3 planes the number of new findings was increased by 9%, and additional findings were made in 36% of the cases studied. The diagnostic symptoms observed were classified as normal, morphologic or topographic changes, space-occupying lesions, foggy scan, biliary, cardiac, or diaphragmatic changes and hepato-splenic scan. Compared to results of x-ray, laboratory, and pathological examinations, there was good correlation in 95% of cases of parasitic liver diseases, but only in 50% of the cases with biliary pathology and in 70 to 88% of cases with other liver diseases. (BBB)

Radiotherapy

Refer also to abstracts 26801, 26826, 26827, 26914, 26918, 26939, 36943, 36945, 26946, 26948–26950, 26952, and 26953.

26852 (CONF-661131–) FAST NEUTRON RADIOTHERAPY SYMPOSIUM, S.E.R.L., 30TH NOVEMBER 1966. (Services Electronics Research Lab., Baldock (England)). 20p. Dep.

Abstracts of 15 papers are presented. The presentations abstracted are: “The Responses of Pig Skin to Fractionated Treatments with X rays and Fast Neutrons” by D. K. Bailey; “Relative Effects of Fast Neutrons and X rays in a Transplanted Tumor and in Normal Tissue” by S. B. Field; “Effects of 14 MeV Monoenergetic Fast Neutrons and Other Radiations on Isologous Mouse Leukemia Cells Irradiated in vivo” by R. J. Berry; “Neutron Generator Tubes” by J. D. L. H. Wood; “Development of a Neutron Source for Routine Radiotherapy” by M. Hillier; “Commercial Neutron Tube Systems” by C. H. Gill; “Collimation and Properties of 14 MeV Neutron Beams” by D. Greene; “The Chapelcross Neutron Facility” by D. E. Watt; “Isodose Curves and LET Spectra for 14 MeV Neutrons” by R. C. Lawson; “Physical and Biophysical Aspects of D-T Neutrons” by J. J. Broerse; “Irradiations of Solid Tumor with D-T Neutrons” by G. W. Barendsen; “RBE of 14 MeV Neutrons in Barley” by M. Ebert; “Studies with HeLa Cells” by A. H. W. Nias; “Clinical Experience with 6 MeV Neutrons” by R. L. Morgan; and “Tentative Thoughts on Therapeutic Trials” by W. Duncan. (H.L.W.)

26853 A THEORETICAL APPROACH TO THE TWO FIELD WEDGE FILTER ^{60}Co IRRADIATION. Svoboda, Jan (Charles Univ., Prague). Strahlentherapie, 136: 671-4(Dec 1968).

A study was made of the important features of the case in which two wedge fields are superposed. The procedure based on the simple mathematical treatment allows the determination of the due dose distribution for any wedge filter. The developed method gives also the dependency of the dose distributions and of the form of the wedge filter on the linear and angular separations of a given field arrangement. (auth)

26854 HYPOPHYSIOLYSIS, DIABETIC RETINOPATHY, AND CANCER OF THE BREAST. Warter, J.; Schwartz, J.; Sibilly, A.; Monath, C. (Clinique Medical, Strasbourg). Sem. Hop. Paris, 43: 2637-9(Oct. 20, 1967). (In French).

Radioyttrium (^{90}Y) was used to treat a 66-yr-old diabetic woman with cancer of the right breast with pleural complications. She had a history of diabetes and had been treated with x rays after surgery 2 yr previously. Hypophysiolysis was performed with ^{90}Y implants made on the right side transorbitally with 5 grains of ^{90}Y, totalling 20 μCi. The patient had forehead pains for 2 weeks Surgical intervention showed the tumor metastases to be greatly affected. Two more implantations were used. There were no after-effects. At first, diabetic symptoms showed no change but after 6 months glycemia had decreased to 150 mg %; glycosuria was almost absent; and diabetic retinopathy was clearly improved with only slight hemorrhage. Besides the effect of ^{90}Y hypophysiolysis on hormone-related cancer, its effect on diabetes and diabetic retinopathy was considered to be of great importance in relief of the patient's symptons. (BBB)

26855 IMPLANTATION OF ^{90}Y IN AN ACROMEGALIC PATIENT: REPORT OF A CASE. Gelinas, J. Jacques; McCullagh, E. Perry; Dohn, Donald F. (Cleveland Clinic). Cleveland Clin. Quart., 33: 171-8(Oct. 1966).

The effects of treatment of an acromegalic patient by transnasal implantation of 2 sources of ^{90}Y (5 mCi and 5.12 mCi) in the pituitary are reported. Roentgenograms of the skull and hands did not change appreciably after the operation. Serum phosphorus concentration decreased from 4.0 preoperatively to 3.0 mg/100 ml. Determinations of urinary gonadotropins, thyroid function, and glucose tolerance were essentially unchanged. The blood growth-hormone concentration decreased postoperatively to $\frac{1}{6}$th preoperative level and there was no increase after administration of insulin. The Metopirone test performed postoperatively showed limited pituitary reserve, which could be due to the acromegaly itself or to the hypophysectomy. (BBB)

26856 RADIUM THERAPY OF THE INDURATIO PENIS PLASTICA. Ludvik, W.; Wasserburger, K. (Univ., Vienna). Z. Urol., 61: 319-25(May 1968). (In German).

Results of 259 cases of plastic penile induration with Ra irradiation were reported and discussed. The treatments were administered by application of a 7 mm thick moulage in which were imbedded 15 to 18 Ra cells 1 cm long. The cells were filtered with a 0.2 mm Pb equivalent, so that the γ irradiation was accompanied by a small amount of β irradiation. The moulage was modeled so that the Ra-skin distance was 7 mm. The skin dose measured was 3000 R at the middle of the moulage, and at each end it was about 30% less because of the linear arrangement of the Ra cells. It was estimated that the dose in the urethra was 10% lower. In 11 of the cases treated by Ra, chronic helical nodular chondrodermatitis was observed, and in 141 cases there was Dupuytren's contracture. In addition to these irradiation effects, indurations were observed in 5 patients. (BBB)

26857 ACROMEGALY: PHYSIOPATHOLOGY AND PROSPECTIVE NEW THERAPY. Dogliotti, G. C. (Univ., Turin). Minerva Med., 60: 287-97(Jan. 27, 1969). (In Italian).

A case of acromegaly is presented in order to discuss some aspects of its diagnosis, prognosis, and therapy. The diagnosis of this pathological condition presents some difficulties in the initial phases of the illness and these are discussed. The reasons for the poor prognosis are considered. The classical therapy is described, and a new method of therapy using infusions of ^{198}Au and ^{90}Y is discussed. The infusion of ^{90}Y did not block the development of the pathological condition, but caused marked general improvement. (J.S.R.)

26858 WHEN AND HOW TO USE HIGHER ^{131}I DOSES FOR HYPERTHYROIDISM. Hamburger, Joel I.; Paul, Sukhamoy (Northland Radioisotope Lab., Southfield, Mich.). New Engl. J. Med., 279: 1361-5(Dec. 19, 1968).

Indications are given for using elevated doses of ^{131}I in hyperthyroid patients as well as methods used to prepare them for such doses. of 356 ^{131}I-treated hyperthyroid patients, 54 were selected for doses of 20 to 100 mCi because of heart disease, toxic nodular goiter, or massive toxic diffuse goiter. Two euthyroid patients with progressive infiltrative ophthalmopathy and nonsuppressible function after previous surgery were also treated. Measures to protect heart patients from ^{131}I-induced thyroxine discharge included adjustment of cardiac medications, reserpine, antithyroid drug pretreatment, and hospitalization. Hypothyroidism was anticipated in patients with toxic diffuse goiter, and substitution therapy administered promptly. No adverse reactions occurred. Hyperthyroidism was controlled with one ^{131}I dose in all but two patients, who required an additional dose. Hypothyroidism occurred in two of 36 patients with toxic nodular goiter, and 17 of 19 with toxic diffuse goiter. The euthyroid state was achieved in one to three months in 51 patients and within six months in two patients. With proper pretherapy, large doses of ^{131}I may safely be administered to hyperthyroid patients, even with complicating heart disease. (BBB)

26859 PREVENTION OF GYNECOMASTY IN HORMONE-TREATED PROSTATIC CARCINOMA PATIENTS BY X IRRADIATION OF THE MAMILLA (MAMMA VIRILIS). Zingg, E.; Heinzel, F. (Urologische Univ., Zurich). Urologe, 7: 96-7(Mar.-Apr. 1968). (In German).

Effects in prostatic cancer patients given about 800 R focal dose of x irradiation to prevent gynecomasty resulted in considerable erythema 10 days later, with a very slight pigmentation after 6 weeks which slowly disappeared. After a higher dose of about 1400 to 2400 R, exudative skin reactions were observed. If the irradiation was performed after hormone treatment of the patient was started, doses of 3000 R or more, which caused contraction and induration of the connective tissue, were required to treat breast hyperplasia. Irradiation of girls in the mammary region because of hemangioma or keloid scars before puberty prevented or inhibited mammary development at relatively low doses of 400 to 600 R. The mamma of the adult male has a similar radiosensitivity. Irradiation of the male mamma before hormone treatment decreased the number of lactiferous ducts considerably, and reduced the size of the breasts by a factor of 7 or 8. (BBB)

26860 X-RAY THERAPY FOR ACUTE PANCREATITIS. Wachtfeidl, Viktor; Vitez, Milos. Amer. J. Surg., 116: 853-67 (Dec. 1968).

Experimental bases for and clinical results of irradiation for the treatment of acute pancreatitis are presented. In animal studies, secretory inhibition of the pancreatic enzymes was demonstrated after x irradiation. The inhibition of hormone secretion was usually temporary but permanent after very high doses. Permanent morphologic changes were not demonstrated even after high doses. The islets of Langerhans are less radiosensitive than the outer secretory parenchyma. In vitro experiments indicate that x radiation inhibits the activity of enzymes which have been released by the pancreas and which have infiltrated the extrapancreatic tissue. Successful results of radiotherapy in 10 patients with pancreatitis are reported. (BBB)

26861 PRESERVATION OF PULP AFFECTED BY SEROUS INFLAMMATION WITH ULTRASHORT WAVES. Pissarev, J. Deut. Zahnaertztl. Z., 23: 991-9(1968). (In German).

The effect of ultrashortwave irradiation on temperature changes, capillary flow, and microflora was determined in patients with inflamed dental pulp. It was observed that the action of ultrashort waves in the region of the oral cavity resulted not only in an increase of the local temperature, but also a decrease of bacteria in dental pulp which showed serous inflammation. After removal of the carious dentin from teeth with severely inflamed pulp, as well as in cases with deep caries, chlorophenol camphene was inserted before ultrashort wave treatment. After the pain had subsided a permanent filling was inserted. Among 152 cases, positive clinical results were obtained in 89%. In histological sections of successfully treated teeth which were extracted at various times after treatment, normal pulp tissue was seen, with no evidence of inflammation. (BBB)

Blast and Thermal Effects

Refer to abstract 26709.

Radiation Effects on Animals

26862 INTERMEDIATE FORMS BETWEEN HeLa CELLS AND FEEDER CELLS OF THE SAME ORIGIN. PRELIMINARY REPORT. Berger, Hans Ekkehard (Univ., Tuebingen, Ger.). Strahlentherapie, 136: 758-60(Dec. 1968). (In German).

Mixing unirradiated HeLa cells with lethally irradiated feeder-cells under previously described conditions leads in a certain fraction of cases to a large variety of intermediary forms, some of which seem to benefit from the feeding action of the degenerating cells while others show predominantly degenerative changes. From the standpoint of population dynamics the feeding action seems to exceed by far the toxic effects of feeder cells. It should not be forgotten, however, that the beneficiaries do not necessarily represent the majority of cells affected this way in the beginning. (auth)

26863 EFFECTS OF X RAYS ON PLOIDY AND LOCOMOTION RATE OF GRANULOBLASTS IN VITRO (PHASE-CONTRAST MICROCINEMATOGRAPHIC STUDIES). **Rondanelli, E. G.; Gerna, G.; Carosi, G.; Mazza, A. (Univ., Pavia, Italy). Pathol. Biol., Sem. Hop., 16: 139-46(Feb. 1968).**

A comparative study of the migration rate of normal newt granuloblasts and heteroploid granuloblasts derived from asymmetrical karyokinesis induced in newt spleen culture by small doses of x rays is reported. The investigation was carried out on migrating neutrophil granuloblasts of a newt, Molge vulgaris, spleen culture. The dose used was of the order of 25 R. The preparations were examined 24 to 36 hr after the exposure. Measurements were taken during a period of at least 15 min for each cell. The microscope was placed in a thermostatic chamber maintained at 26°C during the period of observation. The micrometric data indicated that the heteroploid status had no statistically significant effect on the speed of migration of the cell with abnormal karyotype, compared with controls. Examination of microcinematographic sequences showed that the morphological appearances associated with cellular migration of heteroploid cells were comparable to those of normoploid granuloblasts. The possible factors involved in the pathogenesis of the status of heteroploidy and the functional significance of the centrosphere in cellular locomotion were discussed. (BBB)

26864 SURVIVAL OF MAMMALIAN CELLS EXPOSED TO X RAYS AT ULTRA-HIGH DOSE-RATES. Berry, Roger J. (Churchill Hospital, Oxford); Hall, Eric J.; Forster, David W.; Storr, Thomas H.; Goodman, Michael J. Brit. J. Radiol., 42: 102-7(Feb. 1969).

X irradiation delivered in single, nanosecond-length pulses, so that the instantaneous dose-rate exceeded 7×10^{10} rads/second, was less effective in abolishing the subsequent reproductive capacity of HeLa and Chinese hamster cells in vitro than was irradiation delivered at lower dose-rates. It was felt that this was not caused by the production of transient intracellular hypoxia during the radiation pulse in these mammalian cells, and an alternative hypothesis is proposed to explain these results. Possible applications of ultra-high dose-rate irradiation in radiotherapy are discussed. (auth)

26865 CHANGES OF THE INTENSITY OF ULTRAVIOLET FLUORESCENCE OF PERIPHERAL BLOOD LEUCOCYTES UNDER VARIOUS CONDITIONS OF IRRADIATION. **Brumberg, I. E. (Central Research Inst. of Roentgenology and Radiology, Leningrad). Tsitologiya, 11: 251-4(Feb. 1969). (In Russian).**

The intensity of uv fluorescence of peripheral blood leukocytes was found to depend on the dose of irradiation but it was not shown to depend on the fractionation and dosage of irradiation. (auth)

Invertebrates

Refer also to abstracts 26718, 26721, 26734, 26742, and 26974.

26866 EFFECTS OF GAMMA RADIATION ON IN VITRO GROWTH AND IN VIVO PATHOGENICITY OF HISTOMONAS MELEAGRIDIS. **Ruff, Michael David. Manhattan, Kan., Kansas State Univ., 1968. 178p.**

Thesis.

The effects of γ radiation from ^{60}Co on the growth of Histomonas meleagridis in DeVolt's alkaline serum media and the effect on the in vivo pathogenicity were studied. In experiments to determine the LD$_{50}$ of Histomonas, organisms were exposed to various doses of γ rays from 0 to 500 KR. Histomonads were counted immediately after radiation and 24 hr later. The LD$_{50}$ for cultures grown 28 to 54 days in vitro was 400 KR. An age effect on radiosensitivity was found as culture grown for 209 days had an LD$_{50}$ of 80 KR. A series of studies were made on the effects of γ radiation on growth of the organism by making counts each day for a number of days after exposure. No effect was found with exposure to 50 KR when compared with the Controls. Doses of 150 to 200 KR retarded growth. A relationship was found between an extended lag phase and the level of exposure. Stimulation occurred with exposure to 100 KR. The range of this stimulation of growth was narrow as 75 and 125 KR retarded growth, when compared with the Controls. Some of the changes in growth were transmitted to subsequent generations. Data from the subculture of exposed cultures indicated that organisms in the 100 and 150 KR groups grew to a higher level (greater numbers) than the Control group. Growth in the 200 KR group was comparable with the Controls. A significant decrease in the size of organisms was found seven days post radiation in the 150 to 200 KR groups when compared with the controls. An extension of the number of days during which logarithmic growth occurred was found in some of the irradiated groups. DeVolt's medium was exposed to 0, 50, 100, 200, and 300 KR to determine if irradiated medium had any effect on growth. No effect was observed with exposure to 50 KR. Exposures of 100 and 200 KR retarded growth while even greater reduction in growth was observed with 300 KR. Histomonas grown for seven days in the medium exposed to 300 KR were significantly larger than those in the Control group. Histomonas exposed to 35, 70, 139, 208, and 277 KR were inoculated into turkeys by intrarectal infection. A delay was observed in the time of occurrence of sulfur-yellow feces which was related to the dosage given. A reduction in the time of death and mortality was also found. Surviving birds were challenged with nonirradiated organisms to determine if any immunity had been induced by infection with the irradiated organism. Results of these studies showed that no immunity was produced. Histomonas isolated from the surviving birds at the time of challenge were maintained in cultures for several weeks. The results of infecting turkeys with these organisms indicated that a strain of reduced pathogenicity had been recovered. Data obtained by growing Histomonas for one week after radiation showed that when they were cultured 148 days in vitro they could not survive exposure to 320 KR while those grown for 209 days could survive only 250 KR. A great increase in survival was found with the addition of nonirradiated cecal bacteria after exposure. Histomonas is dependent on the associated cecal bacteria present in DeVolt's media for a growth factor of unknown composition. Several effects of radiation such as extended lag phase and mortality could be overcome with the addition of such bacteria. (Disser. Abstr.)

Vertebrates

Refer also to abstracts 26648, 26666, 26677, 26686, 26687, 26689, 26692, 26697–26703, 26712, 26725, 26737, 26740, 26743, 26821, 26825, 26828, 26830, and 26852.

26867 (AD–672738) COMPARATIVE HEMATOPOIETIC CYTOKINETICS IN RATS EXPOSED TO EITHER 250 kVp X RAY OR MIXED GAMMA-NEUTRON RADIATION. **Baum, S. J.; Wyant, D. E.; Vagher, J. P. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Jan. 1968. 31p. (AFRRI-SR-68-2). CFSTI.**

The experiment was designed to obtain recovery and residual injury data on hematopoietic stem cells of 6 groups of polycythemic rats exposed to one of three relatively low doses (150, 200, and 250 rads) from one of two radiation sources. The radiation sources were a 250 kVp x-ray generator and the AFRRI-TRIGA Mark F reactor. About 60 percent of the dose produced by the reactor was from gamma rays; the remainder was from neutrons. In the polycythemic rats, the response of hematological stem cells to erythropoietin as measured by ^{59}Fe uptake in the progeny of these cells, was utilized as a measure of the effects of the irradiation. Peripheral leukocyte counts were obtained to assess competitive stimulation of related blood cells upon the hypothesized multipotential stem cell pool. It was observed that stem cell injury increases significantly with increasing radiation dose as expressed in the first rapid recovery phase. Although recovery responses are dose dependent, they are independent of the type of radiation and, in general, the RBE of gamma-neutron radiation appears to be 1. A significant decrease in the recovery response is observed in animals subjected to a repeated dose of 200 or 250 rads after a 90-day rest period. Leukopoietic recovery, as noted in the circulatory blood, begins approximately 8 days after exposure. The data suggest that the postirradiation physiological adjustments in the rat initiated by recovery and subsequent cellular proliferation result in the early abortive cellular rise and its termination. In this investigation, the residual injury observed after a repeated radiation exposure could be the result of faulty recovery in a number of primitive progenitor cells. (auth) (USGRDR)

26868 (AD–672739) EFFECTIVENESS OF DRUGS IN ANIMALS EXPOSED TO MIXED GAMMA-NEUTRON RADIATIONS. I. HYPOGLYCEMIC AGENTS. **Davis, L. W.; Brown, J. A.; Strike, T. A. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). May 1968. 24p. (AFRRI-SR-68-9). CFSTI.**

The effect of 200, 1,000, and 5,000 rads of mixed gamma-neutron radiations on total blood reducing sugar and blood glucose levels in guinea pigs was investigated at 2 and 24 hours, 9, 22, and 60 days postirradiation. In addition, the effectiveness of insulin and tolbutamide was evaluated before and after these doses of radiation. Glucose increased to a lesser degree and later than did the nonglucose fraction of the blood sugar. Insulin and tolbutamide were effective following irradiation except after 5,000 rads, when tolbutamide was significantly less effective. These results suggest insufficient insulin is released by the pancreas in response to elevated blood sugar levels following irradiation, the pancreas does produce insulin at these times and is able to release it in response to tolbutamide, and a decrease in insulin production occurs following supralethal doses of radiation. (USGRDR)

26869 (AD–672740) EFFECTIVENESS OF DRUGS IN ANIMALS EXPOSED TO MIXED GAMMA-NEUTRON RADIATIONS. II. ANTICONVULSANTS. Davis, L. W.; Strike, T. A. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). May 1968. 23p. (AFRRI-SR–68-10). CFSTI.

The effectiveness of four anticonvulsants was tested in male CF1 mice exposed to 500-, 1000-, and 10,000-rad doses of mixed γ-neutron radiations. Prevention of the hind leg extensor component of a maximal convulsion induced by electroshock was selected as the end point for effective anticonvulsant activity of diphenylhydantoin, phenobarbital, and mephenytoin. Prevention of convulsions induced by pentylenetetrazol was the end point of effective anticonvulsant activity of trimethadione. The effectiveness of the drugs was evaluated by comparing the ED_{50}'s to the ED_{50} value of unirradiated controls. The anticonvulsants tested by electroshock showed a tendency toward increasing effectiveness after 500- and 1000-rad doses of radiation and a significantly increased effectiveness following 10,000 rads. Trimethadione effectiveness in irradiated mice was similar to that in unirradiated controls at all doses and times. (auth) (USGRDR)

26870 (AD–672741) EFFECTIVENESS OF DRUGS IN ANIMALS EXPOSED TO MIXED GAMMA-NEUTRON RADIATIONS. III. PSYCHOPHARMACOLOGIC AGENTS. Davis, L. W.; Strike, T. A. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). May 1968. 19p. (AFRRI-SR–68-11). CFSTI.

Chlorpromaxine, triflupromazine, and chlordiazepoxide were studied for their effectiveness in irradiated male Sprague-Dawley rats at selected times following 500, 1000, and 10,000 rad whole-body doses of mixed gamma-neutron radiations. A conditioned response was used to test the drugs' effectiveness. Drug effectiveness decreased in the rats receiving 1000 rads and increased in those receiving 10,000 rads when compared to unirradiated controls. (auth) (USGRDR)

26871 (AD–672819) FLUOROMETRIC DETECTION OF BIOLOGIC CHANGES IN IRRADIATED LABORATORY ANIMALS. Final Report, October 1966–November 1967. Demetriou, James A.; Beattie, John M. (Northrop Corporate Labs., Hawthorne, Calif.). May 1968. Contract F41609-67-C-0036. 30p. (SAM-TR–68-43). CFSTI.

The excretion of fluorescent products by rodents and primates after exposure to whole-body sublethal ^{60}Co γ irradiation was investigated. Gel filtration chromatography and thin-layer chromatography were used to fractionate and quantitate radiation-responsive fluorescent urinary products. A major advancement in quantitating fluorescent urine products was achieved by the fluorescence-scanning of thin-layer chromatograms. Certain radiation dose-response relations were measurable in two major fluorescent fractions from gel filtration chromatography and thin-layer chromatography of rodent and primate urine extracts within twenty-four hr postirradiation. Species variations between rodents and primates may account for different responses of fluorescent urinary products after irradiation. (auth) (USGRDR)

26872 (AD–672895) EFFECTIVENESS OF DRUGS IN ANIMALS EXPOSED TO MIXED GAMMA-NEUTRON RADIATIONS. IV. DRUG TOXICITY. Davis, L. W.; Strike, T. A. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). May 1968. 20p. (AFRRI-SR–68-12). CFSTI.

The acute toxicity (death within 24 hours) of 10 drugs representing four drug classes (anticonvulsants, hypnotics, hypoglycemics, and psychopharmacologics) was studied in irradiated male CF1 mice 2 hr, 1 day, or 6 days after 500-, 1000-, and 10,000-rad whole-body doses of mixed γ-neutron radiations. The LD_{50} value for each drug in irradiated mice was calculated and compared to the LD_{50} value obtained in unirradiated controls. Although the LD_{50} values for most drugs studied were altered significantly in some of the dose groups of irradiated mice, no definite pattern of change of drug toxicity with respect to either radiation dose or postirradiation time was identified. (auth) (USGRDR)

26873 (AD–674860) EFFECT OF PREIRRADIATION AND POSTIRRADIATION ERYTHROPOIETIC STIMULATION ON SURVIVAL FOLLOWING EXPOSURE TO HEMATOPOIETICALLY LETHAL X-RAY DOSES. Scientific Report. Okunewick, J. P.; Hartley, K. M. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). May 1968. 24p. (AFRRI-SR–68-13). CFSTI.

Experiments were carried out to evaluate the effect of erythropoietic stimulation on postirradiation survival. A/He and Swiss mice were stimulated to produce red cells at a greater than normal rate through the use of a high altitude chamber. The response to stimulation both before x irradiation and after irradiation was examined and compared with that shown by simultaneously irradiated but unstimulated control animals. The mice were maintained at a normal atmosphere for about three hours after irradiation in the case of the postirradiation stimulation and for three days prior to irradiation in the case of the preirradiation stimulation. The effect of postirradiation stimulation was tested at 700 and 775 R. The poststimulated mice demonstrated poorer survival than the unstimulated controls. These doses were 100 percent lethal at 30 days to both groups, however, the mean survival time of the irradiated, stimulated mice was shorter than that of irradiated, unstimulated controls, 4.9 days versus 5.9 days, respectively, at 775 R, and 5.9 days versus 7.4 days at 700 R. In contrast, mice which were previously erythropoietically stimulated by three weeks continuous exposure to one-half atmosphere exhibited a markedly better postirradiation survival than did the unstimulated controls. The effect of preirradiation stimulation was tested at 675 R, 725 R, and 775 R. Increased 30-day survival of the prestimulated animals over that of the untreated controls was found at all doses. (TAB)

26874 (N–68-36069) EFFECTS OF REPEATED LOW DOSE X-IRRADIATION ON DISCRIMINATION AND RADIOSENSITIVITY. Johnson, James Michael (Florida State Univ., Tallahassee). 1967. 110p. CFSTI.

Thesis.

Twelve male albino rats were trained on a two bar discrimination task. They were required to emit a specified minimum number of responses to the left bar of a Skinner box and then one additional response to the right bar for each reinforcement obtained. Following initial training, the Ss were divided into four groups of three animals each. Each group was then exposed to 0 R (control), 7 R (low), 14 R (medium) or 21 R (high) doses of x radiation each day at the rate of 7 R per minute. Employing the same discrimination task, behavioral assessments of the radiation effects were calculated for the days of stable responding on two different ratio requirements. Some of the conclusions were that an amount of radiation is less effective when delivered in fractionated doses than a dose of equal magnitude delivered in a single exposure. Also, a history of low-dose exposures sensitizes an animal to later high dose exposure. It makes him less able to sustain the radiation injury. (STAR)

26875 (N–69-18668) HEMATOLOGICAL RESPONSE IN SHEEP GIVEN PROTRACTED EXPOSURES TO ^{60}Co GAMMA RADIATION. Still, E. T.; Taketa, S. T.; Ainsworth, E. J.; Leong, G. F.; Taylor, J. F. (Naval Radiological Defense Lab., San Francisco, Calif.). Feb. 13, 1969. 17p. (NASA-CR–73286). CFSTI.

The changes in the total leukocytes in sheep irradiated with ^{60}Co gamma at a rate of 1.9 R/hr have been determined. After 50 R total exposure, maximum depression occurred 24 hours later. After 100 R or 175 R, maximum depression occurred within one hour. Recovery to control values was seen by 8–9 days for all three exposure groups. The recovery pattern for the circulating leukocytes was qualitatively the same for each of the three groups. An early lymphopenia was seen in all the groups, with recovery to the normal by 5–8 days. The percentage of neutrophils was greatly increased during the first 5 days. The data indicate that total leukocyte counts may not be a reliable means of predicting the exposure an animal sustains under protracted irradiation conditions. (auth) (STAR)

26876 (ORNL-tr–2135) RESULTS OBTAINED IN MICROBIOLOGICAL TESTS OF MEAT OF SLAUGHTERED SWINE AFFLICTED BY RADIATION SICKNESS. Pawel, O.; Kalousova, V.; Vranovska, J. Translated for Oak Ridge National Lab., Tenn., from Vet. Med. (Prague), 12: 361-6(1967). 8p. Dep. CFSTI.

The development of bacteremia was investigated in 67 pigs with radiation sickness. Animals were killed at three stages of the development of acute radiation sickness and lymph nodes and muscles were examined. It was found that microorganisms penetrated through the intestine before clinical symptoms appeared. Organisms were found in all of the organs, especially in the liver and spleen. No representatives of the principal infectious diseases of pigs were found. The majority of microorganisms found were coliform bacteria and streptococci. (H.L.W.)

26877 (UR–49-1028) ACUTE TOXIC EFFECTS OF ^{90}Sr IN NEWBORN RATS. Hopkins, B. J. H. (Rochester Univ., N. Y. Dept. of Radiation Biology and Biophysics). Dec. 9, 1968. 22p. Dep. CFSTI.

Rats of the Long-Evans strain were given an intraperitoneal dose of ^{90}Sr on the second day following birth. A total of 112 experimental animals received 2.0 microcuries of ^{90}Sr per gram of body weight and 68 controls received a dummy injection of acidified sodium chloride solution. The retention of strontium and the growth, survival, and pathological changes in the skeleton were measured during the neonatal period. The strontium-treated offspring retained 91% of the injected dose at 30 days following administration. At this time, 72% of the control rats were alive compared with 67% of the Sr-treated animals. When compared with controls, there was severe retardation of growth, neuromuscular disturbances, and various pathological changes in the skeleton of the Sr-treated rats. These data showed that the dose administered was extremely toxic and further provided information on the mechanisms of toxic effects of radioactive strontium. (auth)

26878 MORPHOLOGICAL CHANGES IN GANGLIA OF SOLAR PLEXUS UNDER THE EFFECT OF TOTAL X-IRRADIATION. Dumbrova, N. E. (Inst. of Physiology, Kiev). Fiziol. Zh., Akad. Nauk Ukr. RSR, 15: 76-83(Jan.-Feb. 1969). (In Ukrainian).

Microscopic and submicroscopic changes in the ganglia of the solar plexus of rats were studied following whole-body x irradiation at doses of 100, 300, and 800 R. A variety of disorders of the nerve elements developed; the type of disorder was related to the radiation dose. Compensation and recovery processes were correlated with the pathology of the lesions. Visual signs of lesions were not always present. The data indicate that this part of the nervous system is relatively resistant to x radiation. (H.L.W.)

26879 COMPONENTS OF GROWTH IN PEROMYSCUS POLIONOTUS. Golley, Frank B.; Carmon, James L.; Williams, Roger; McGinnis, John (Univ. of Georgia, Athens). Growth, 32: 103-11(June 1968).

In an investigation of the effect of low level, acute γ radiation on the old-field mouse, *P. polionotus*, the population characteristics being studied were reproduction, growth, and mortality. In each instance, parameters in mice derived from wild-trapped parents were compared generation by generation in radiation-treated and untreated animals. Growth in length and weight of various skeleton and organ components of total growth was determined in nonirradiated animals to obtain data for comparisons with other treatments and species. The growth curves showed that total body weight in females was generally greater than that in males, especially after 30 days of age. In contrast, gutted body weight was statistically the same in both sexes. Length of the appendages, tail, hind foot, and ear was not significantly different in the sexes. On the other hand, weights of viscera were generally greater in females than in males throughout growth. Viscera included brain, right and left kidneys, heart, lungs, spleen, and liver. Length of the intestine and the stomach was not significantly different in males and females. However, the length of the large intestine was greater in males. Length measurements reached asymptote earlier than weight components, with the exception of the brain which reached asymptote on about day 15. Testes continued growth throughout the 70-day period of study. Correlation coefficients were positive and significant for almost all components during growth except the spleen. (BBB)

26880 REACTION OF ULTRASTRUCTURES OF VARIOUS FUNCTIONING NEUROSECRETORY CELLS TO GENERAL IRRADIATION. Voitkevich, A. A.; Dedov, I. I. (Moscow Inst. of Medical Radiology). Probl. Endokrinol., 15: No. 2, 60-5(Mar.-Apr. 1969). (In Russian).

The results of studying the radioinjury of submicroscopic structures of neurosecretory cells of a supraoptic nucleus in albino linear mice in relation to their functional condition are presented. Experiments were carried out on male Wistar rats. Functional stimulation of neurons preceding the irradiation was induced by phenamine, and inhibition—by chlorpromazine. The animals were irradiated by a completely lethal dose of 900 r, the dose rate being 77 r/sec. As shown, preliminary phenamine stimulation of neurosecretory cells accelerated the occurrence and development of destructive processes in various organoids. Twelve hrs after the irradiation the first to deform were mitochondria, in which cristae become fragmented and matrix underwent lysis; the activity of succino-dehydrogenase diminished. Reduction of ribosomes and disorganization of ergastoplasma occurred two to three days after the radiation action without any association with lysomes. Neurons functionally inhibited before irradiation possess increased resistance to the action of radiant energy. In such cells destruction of mitochondria was revealed only five to six days after the irradiation. Degenerative changes of the Golgi complex, ergastoplasm, and other submicroscopic structures belong to the culminative phase of radiation sickness (the 10th to 14th day). This was accompanied by mass formation of lysosomes. Some biological regularity on the relation of the final effect of ionizing radiation on the initial functional condition of subunits also concerns the neurosecretory cells of hypothalamic nuclei. (auth)

26881 THE DISTRIBUTION OF COLLOIDAL THORIUM DIOXIDE IN MOUSE LIVER AFTER INTRAVENOUS INJECTION. Hampton, J. C.; Rosario, B. (Northwestern Univ. Medical School, Chicago). Contract AT(11-1)-1244. Ann. N. Y. Acad. Sci., 145: 533-44(Dec. 11, 1967).

From Conference on Distribution, Retention, and Late Effects of Thorium Dioxide, New York. See CONF-660422.

An attempt was made to accelerate the accumulation of ThO_2 by mice in order to simulate in mouse liver the chronic effects of large doses in man. Mice were injected by way of either the spleen or portal vein with amounts of Thorotrast equivalent to about six to 30% of their total blood volume. Histological specimens from the liver of controls, animals killed 10 min after injection, and animals killed one month after injection were examined by light and electron microscopy. The distribution of Thorotrast in the liver was not significantly different for doses of 0.1, 0.25, and 0.5 ml. Ten min after injection, particles were still present extracellularly in sinusoidal lumens, in the space of Disse, and in spaces between hepatic parenchymal cells. Many particles were bound to the plasma membranes of and within the cytoplasm of Kupffer cells. The particles did not appear to be bound to the plasma membrane of parenchymal cells but rather taken up by them through vesicle formation both at the cell surfaces bordering the space of Disse and bordering the intercellular spaces. One month after injection, sinusoids were occluded by large Kupffer cells packed with particles. The space of Disse surrounding occuluded sinusoids was obliterated and often contained bundles of collagen. Dense aggregates of particles were found in parenchymal cells and occasionally in bile canaliculi. On rare occasions loose aggregates of particles were found in parenchymal cell nuclei. (M.M.B.)

26882 THOROTRAST LOCALIZATION BY LIGHT AND ELECTRON MICROSCOPY. Tessmer, C. F.; Chang, J. P. (Univ. of Texas, Houston). Ann. N. Y. Acad. Sci., 145: 545-75 (Dec. 11, 1967).

From Conference on Distribution, Retention, and Late Effects of Thorium Dioxide, New York. See CONF-660422.

Observations on the distribution and localization of Thorotrast in rat liver are described. Rats were given 0.5 ml of Thorotrast into the jugular vein. Livers were biopsied at one, three, five, 33, 84, 185, and 306 days after administration. The distribution pattern of Thorotrast in the liver had a major cycle in Kupffer cells and a minor cycle in hepatic cells. The Kupffer cells seemed to be physically tolerant to Thorotrast. They underwent a multiplicative response (proliferative or accumulative or both) and had limited degeneration and fibrosis. Later response included a less reactive stage with large amounts of Thorotrast in clusters of some cells. The two responses apparently occurred in sequence in the rat, the second one implied less active tissue response. These results suggested a basis for the fact that fibrous response is sometimes present and sometimes absent in human cases. Relative density of the Thorotrast aggregates as determined by ultrastructure may provide an index of redistribution. (M.M.B.)

26883 TUMORS IN RABBITS AFTER INJECTION OF VARIOUS AMOUNTS OF THORIUM DIOXIDE. Johansen, Charles (Bispebjerg Hospital, Copenhagen). Ann. N. Y. Acad. Sci., 145: 724-7(Dec. 11, 1967).

From Conference on Distribution, Retention, and Late Effects of Thorium Dioxide, New York. See CONF-660422.

Rabbits were injected with Thorotrast doses ranging from 0.2 to 5 ml/kg. The average lifetime decreased with increasing dose from five yr for controls to 2¼ for high doses. The predominant cause of death was disseminated reticulo-endotheliosarcoma that increased in incidence with increasing dose. In most cases the tumors were found in the liver and spleen; in two-thirds of the cases, in the lungs; while other organs were involved in about one-third of the cases. It was concluded that perivascular depots may give rise to local, metastasizing fibrosarcoma. Endometrial carcinoma and various other tumors were also found, but appear to be unrelated to the thorium injection. (M.M.B.)

26884 EXPERIMENTAL STUDIES IN MICE ON THE LATE EFFECTS OF RADIOACTIVE AND NONRADIOACTIVE CONTRAST MEDIA. Bensted, J. P. M. (Inst. of Cancer Research, Sutton, Eng.). Ann. N. Y. Acad. Sci., 145: 728-37(Dec. 11, 1967).

From Conference on Distribution, Retention, and Late Effects of Thorium Dioxide, New York. See CONF-660422.

Mice were injected with Thorotrast, zirconotrast (a nonradioactive zirconium hydroxide sol), or dextran (used in preparation of the colloids) in order to establish whether the late carcinogenic effects of Thorotrast are a result of its radioactivity. Preliminary results have revealed numerous vascular tumors of the spleen, but not the liver, in the Thorotrast injected but not the zirconotrast injected mice. None of these tumors occurred before 23 months after injection. Current experiments with ionium-enriched Thorotrast have resulted in numerous deaths from anemia after high doses and high incidence of myelogenous leukemia after low doses. (M.M.B.)

26885 LIVER DISTRIBUTION OF COLLOIDAL THORIUM DIOXIDE AND DEVELOPMENT OF LIVER EPITHELIAL TUMORS IN RATS. Grampa, Giuseppe (Univ., Milan). Contract 343/RB. Ann. N. Y. Acad. Sci., 145: 738-47(Dec. 11, 1967).

From Conference on Distribution, Retention, and Late Effects of Thorium Dioxide, New York. See CONF-660422.

Male rats of Sprague-Dawley and Wistar strains were injected intravenously with colloidal thorium dioxide. The pattern of colloidal thorium dioxide distribution in the liver was studied with light microscopic, electron microscopic, and autoradiographic techniques. Thorium dioxide is phagocytized very rapidly by Kupffer cells, as early as one minute after injection, and later on, is seen in form of large aggregates, obscuring cellular details. Autoradiographic and electron microscopic observations show that hepatic parenchymal cells do definitely absorb thorium dioxide, even if to a much smaller than Kupffer cells. Foci of histocytic hyperplasia, nodular adenomatous hyperplasia, adenomas, and parenchymal cell carcinomas were observed after an observation period of up to 15 months. Rats injected with India ink, used to test the effect of the presence of particulate nonradioactive material in the liver, gave no remarkable findings in the liver. In order to stimulate the phagocytic activity of the reticuloendothelial system, groups of animals were castrated and treated with estrogens before thorium dioxide and India ink injection. The relationship between thorium dioxide and estrogen treatment and the possible interplay of radiation and hormonal factors, are at present being investigated. (auth)

26886 A COMPARISON OF SERUM TRANSAMINASE LEVELS AND OTHER SERUM CONSTITUENTS IN DOGS BURDENED WITH ^{239}Pu, ^{228}Th, ^{228}Ra, AND ^{226}Ra. Stevens, Walter; Nabors, Charles J. Jr.; Berliner, David L. (Univ. of Utah Coll of Medicine, Salt Lake City). Contract AT(11-1)-119. Ann. N. Y. Acad. Sci., 145: 817-29(Dec. 11, 1967).

From Conference on Distribution, Retention, and Late Effects of Thorium Dioxide, New York. See CONF-660422.

The effects ^{239}Pu, ^{226}Ra, ^{228}Ra, ^{228}Th, and ^{90}Sr on the serum glutamic-oxaloacetic transaminase (SGOT), serum glutamic-pyruvic transaminase (SGPT), serum alkaline phosphatase, serum albumin and globulins and albumin/globulin ratio were studied in dogs. Each animal received a single intravenous injection of the radioisotopes. Blood samples were tested at one, two, and six months and at yearly intervals. The incidence of osteosarcomas increased with increasing dose of radioisotope up to 100%. This increase with dose was accompanied by elevated serum phosphatase measurements. Plutonium-injected dogs had the greatest increase in elevated alkaline phosphatase followed by ^{228}Th, then ^{228}Ra, and finally by ^{226}Ra. It was previously shown that in plutonium-burdened dogs there was a correlation between elevation of SGPT and the dose of plutonium. A less marked correlation was shown for ^{226}Ra. Thorium-228 did not have the same effect as ^{239}Pu did on the SGPT elevation and it did not have a marked effect on serum transaminase. Radium-228 did not have much effect on SGPT at any dose level. The radium isotopes had very little effect on the serum proteins, while Th and Pu produced marked hypoalbuminemia and hyperglobulinemia. The changes in blood chemistry appeared to be determined by the body distribution of the radioisotopes. It was concluded that SGPT and SGOT measurements provide evidence of hepatic damage before it is detectable by other means. (M.M.B.)

26887 ON THE INFLUENCE OF RADIOACTIVE NEOHYDRIN LABELLED WITH ^{203}Hg AND ^{197}Hg ON THE KIDNEY AND LIVER STRUCTURE. Zolotarev, I. I.; Rabina, E. V.; Kim, A. G. (First Moscow Medical Inst.). Byull. Eksp. Biol. Med., 68: No. 3, 112-15(Mar. 1969). (In Russian).

A study was made of the kidneys in 40 and the liver in 20 rabbits that were given neohydrin labeled with ^{203}Hg and ^{197}Hg in increasing doses from 10 to 100 mCi (weight of animals from 1 to 3 kg). Investigations showed that the agent in doses of 1.5 to 2 mCi per kg produced no morphological changes in kidneys and the liver. Minimal changes in kidneys of grain dystrophy type in epithelium of tubuli contorti appeared with overdosage 6 to 10 times over normal, and in the liver as protein and fat dystrophy when the dose was increased 15 to 20 times. Dystrophic changes in kidneys were reversible, regenerative processes appeared three weeks after administration of the drug. (auth)

26888 THE EFFECT OF ^{60}Co IRRADIATION ON THE SYNOVIAL, TENDON, AND MUSCLE TISSUES OF DOGS. Rissanen, Pentti; Rokkanen, Pentti; Paatsama, Saki (University Central Hospital, Helsinki. Coll. of Veterinary Medicine, Helsinki). Strahlentherapie, 136: 705-11(Dec. 1968).

The effect of ^{60}Co irradiation on the normal tendon, synovial, and muscle tissue of 6 adult and 6 growing dogs was investigated. The single doses used ranged from 250 to 4000 rad. A total of 42 sites was irradiated. The results were studied in groups of animals sacrificed at four days, two weeks, and two months, respectively, after irradiation. Histological and histochemical methods and polarised light microscopy were used in the analysis of the results. Incipient changes in the tendon tissue were observed two weeks after irradiation in the growing dogs treated with 500 rad and in the adult dogs treated with 1000 rad. Later, changes were more marked and mainly occurred in the form of disappearance of polarisation, reduction of nuclei and fragmentation of the fibre bundles. Changes in the synovial tissue were discernible as soon as four days after irradiation with 1000 rad or more, initially in the form of endothelial changes. Part of the smaller blood vessels were obliterated two weeks and two months after irradiation. The muscle tissue was radio-resistant in both growing and adult dogs. (auth)

26889 OCULAR EFFECTS PRODUCED BY EXPERIMENTAL LASERS. II. CARBON DIOXIDE LASER. Campbell, Charles J.; Rittler, M. Catherine; Bredemeir, H.; Wallace, Robert A. Amer. J. Ophthalmol., 66: 604-14(Oct. 1968).

The carbon dioxide laser with a manipulator designed to permit surgical procedures was employed in an experimental investigation of the ocular effects produced by this instrument. The laser beam was directed to the cornea of chinchilla rabbits and the pathologic alterations were studied by slit-lamp microscopy and histopathology. The power values of the laser were varied through a relatively wide range. At the higher power settings, necrotic perforating ulcers of the cornea were produced. At the lower settings no effects were detected. Intermediate energy values produced nonpenetrating necrotic ulcers in which the primary effects were located in the more superficial areas of the cornea. The energy necessary to produce a threshold lesion was 68.0 mW delivered to the cornea in three seconds. Threshold and near-threshold lesions were characterized by superficial opacities which generally faded in the course of several weeks. (auth)

26890 OCULAR EFFECTS PRODUCED BY EXPERIMENTAL LASERS. III. NEODYMIUM LASER. Campbell, Charles J.; Rittler, M. Catherine; Innis, Robert E.; Shiner, William H. Amer. J. Ophthalmol., 66: 614-32(Oct. 1968).

High-power lasers with emission wavelengths in and near the visible spectrum are capable of producing significant damage to the cornea and lens of the eye. The energy density required for these lesions, however, is relatively high and is significantly greater than that encountered in nature or in clinical photocoagulation. Within the time interval of postoperative follow-up in this experiment, mild coagulations of the cornea appeared to be at least in part reversible, whereas those in the lens were permanent. The high absorption characteristic of the retinal pigment epithelium caused that structure to be far more sensitive than the cornea and lens to this type of radiation damage. Therefore, most corneal and lens lesions produced in this study were associated with retinal coagulations. This indicates that, even in experimental situations in which ancillary optical systems are employed, retinal effects would probably be more profound in accidental exposures than would corneal and lens damage. The possibility of retinal damage and the production of cataracts indicate that a clinical procedure based on the technique described in this paper would not be useful for the performance of iridectomies. (auth)

26891 INFLUENCE OF RADIOACTIVE SUBSTANCES ON THE EMBRYONIC FISH DEVELOPMENT. Ivanov, V. N. pp 185-9 of Voprosy Biookeanografii. Materialy II Mezhdunarodnogo Okeanograficheskogo Kongressa, 30 Maya–9 Iyunya 1966 g, Moskva. Kiev, Izdatel'stvo Naukova Dumka, 1967. (In Russian).

From 2nd International Oceanographic Congress, Moscow, USSR. See CONF-660574.

In view of the known radiosensitivity of developing organisms, the effect of radiation on fish embryos was investigated, using the roe of various Black Sea fish, such as *Engraulis enchrasicolus ponticus*, *Rhombus maeoticus*, and *Trachurus mediterraneous ponticus*, for investigation. It was found that solutions of ^{90}Sr–^{90}Y, in concentrations of 10^{-8} to 10^{-7} Ci/l resulted in a statistically significant killing of the roe. The malformations were noted by the curvature of the spine, microcephalisis, incorrect position of the yolk sack, abnormal pigmentation of the eyes and body, dropsy, etc. Chronic radiosensitivity at various stages of development was studied using the eggs of the flounder that were placed in a 10^{-6} Ci/l solution ^{144}Ce for 6, 30, 54, 78, and 102 hrs after fecundation. The number of dead embryos depended on the incubation time in the radioactive solution. Eggs placed in the radioactive solution 16 hrs after fecundation, at the time of division, resulted in 44.6% of malformed offspring; the effect of ^{144}Ce at the time of the formation of the tail portion caused anomalies in only 19.1% of the cases. Such studies on the radiosensitivities at various stages of development of the fish egg permit estimation of the radioecological implications of present and anticipated levels of radioactive contamination of the hydrosphere. (TTT)

26892 EFFECT OF TOTAL GAMMA IRRADIATION, VARIOUSLY FRACTIONATED IN TIME, ON REFLEX ACTIVITY OF THE SPINAL CORD: ROLE OF THE TIME FACTOR IN RADIATION EFFECTS ON THE NERVOUS SYSTEM. Kuznetsova, M. A. pp 93-124 of Nekotoryye Voprosy Kosmicheskoy Neyrofiziologii. Moscow, Izdatel'stvo Nauka, 1967. (In Russian).

The effect of single and fractionated doses of γ irradiation (^{60}Co) on functions of the spinal reflex arc was studied in 28 guinea pigs divided into three groups. One group received a single 500 R dose, the second the same amount in 100 R doses applied twice a week at 52 R/min, and the third served as control. Indicators were the altering threshold and latency period of unconditioned defensive motor reflexes to irritation of the hind paw applied at three potencies. The animals were observed on the day after each exposure, and then for another 19 days after the end of the experiment. Blood, behavior and weight were also monitored. Results were compared with those obtained earlier in guinea pigs treated with the same dose at 260 R/min. The results were analyzed according to the stages of N. V. Golikov. Changes caused by the single dose depended on the rate at which it was applied. At the 260 R dose, latency periods increased for all three irritant potencies. In animals subjected to fractionated radiation, increased reflex conductivity prevailed. A qualitative reaction to the first two irritant potencies was statistically confirmed. Single irradiation was almost 100% lethal with acute leukopenia and weight loss, although the animals treated at 52 R/min survived somewhat longer. The mortality in the animals exposed to fractionated irradiation was 33%. Blood tests returned to close to normal values on the 18th day after the experiment, and no differences in weight were observed compared to controls. It was concluded that the time factor played a decisive role and that fractionated irradiation would considerably attenuate radiobiologic reactions, particularly those of the spinal centers. (TSS) (ATD)

26893 THE COMBINED EFFECT ON ANIMAL ORGANISMS OF UHF ELECTROMAGNETIC WAVES AND BREATHING OF A GAS MIXTURE WITH REDUCED OXYGEN CONTENT. Petrov, I. R.; Yarokhno, N. Ya. Voenno Med. Zh., No. 7, 26-30(1967). (In Russian).

The effects of breathing gas mixtures with reduced oxygen content, alone and in combination with exposures to UHF electromagnetic radiation, were studied to provide information on environmental effects on personnel working in radar stations in the mountains. The studies were made on rabbits, simulating altitudes of five and seven km (11.2 and 8.5% oxygen), under UHF electromagnetic intensities of 10 and 30 milliwatt/cm^2. UHF radiation in itself had little effect on arterial pressure or on the erythrocyte or leukocyte content in the blood. Breathing air with reduced oxygen content (11.2%) increased arterial pressure, had little effect on leukocyte content, and increased erythrocyte and blood sugar content—i.e., the organism underwent adaptive reactions to the decreased oxygen content in the air. Combination of UHF electromagnetic radiation and reduced oxygen content results in a decrease in the number of erythrocytes and leukocytes—i.e., in suppression of the organism's adaptive reactions. The 8.5% oxygen atmosphere, alone, and in combination with the 10 milliwatt/cm^2 electromagnetic radiation, also stimulated adaptive reactions, but the seven km atmosphere in combination with the higher intensity electromagnetic radiation again limited the adaptive reactions to oxygen insufficiency. Subjects acclimated to the low oxygen content atmospheres and then subjected to UHF radiation showed little change in arterial pressure and erythrocyte and leukocyte content. It was concluded that personnel from sea level locations brought in to work in radar stations at high altitudes need an acclimation period of about one month before exposure to UHF electromagnetic radiation. (ATD)

26894 RELATIVE BIOLOGIC EFFICIENCY OF FAST NEUTRONS. Gorodetskii, A. A.; Kirichinskii, B. R.; Shur'yan, I. M. (Inst. of Physiology, Kiev). pp 216-22 of Voprosy Biofiziki, Biokhimii i Patologii Eritrotsitov. Moscow, Izdatel'stvo Nauka, 1967. (In Russian).

A discussion is presented of factors affecting the RBE of fast neutrons, including: species, age and health of animal at time of exposure; type of test selected for evaluating radiation injury; length of observation period (with fast neutron irradiation, more significant irradiation injuries appear at remote periods); neutron energy (RBE decreases with increase of neutron energy); nature of irradiation (single or fractional dose) and dose rate (in neutron irradiation, restoration processes play a very small role and thus RBE of fast neutrons sharply increases with repeated exposure); physical conditions at time of exposure (temperature, oxygen effect, and others); presence and value of gamma background; and irradiation dose. In addition to these factors, the position of the animal at time of irradiation is extremely important. Rotation of subject at time of irradiation ensures the most uniform distribution of tissue doses. A comparison is given of the RBE of fast neutrons (VVR-M nuclear reactor, 1 to 2 MeV), x rays (180 kV, 0.5 mm copper filter) and β rays (^{32}P) on the erythropoietic system of 200 rats and 30 rabbits. In all experiments $LD_{50/30}$ irradiation doses were selected. Indices included morphological composition of the peripheral blood, erythrocyte resistance, optical density change of a hemoglobin solution and erythrocyte methemoglobin level. Animals were examined twice before irradiation and every four days during radiation sickness for a 30 day period. Hemopoietic system reactions of animals irradiated with fast neutrons, x rays and β rays in biologic equivalent doses ($LD_{50/30}$) showed that despite the generally similar types of changes there were certain differences. Animals irradiated with fast neutrons displayed sharper and deeper changes of peripheral blood composition. Compared to x irradiation, erythrocyte resistance of fast neutron irradiated animals was markedly lower, blood system balance was significantly disturbed by the quality change of erythropoiesis, and the erythrocyte methemoglobin level was considerably higher. (ATD)

26895 EFFECT OF AN ULTRA-HIGH-FREQUENCY ELECTROMAGNETIC FIELD ON THE PULSE RATE OF CHICK EMBRYOS. Blinkova, T. P.; Bogdanov, O. V.; Yakovleva, M. I. (Inst. of Experimental Medicine, Leningrad). Zh. Evol. Biokhim. Fiziol., 3: 178-81(1967). (In Russian).

Chick embryos aged 14 to 21 days were exposed to UHF electromagnetic fields as follows: single exposure to 12 mw/cm^2 for 30 min; single exposure to 30 mw/cm^2 for 30 min; daily exposure to 30 mw/cm^2 for 3 to 4 days with a duration of 30 min per exposure. It was found that the 12 to 30 mw/cm^2 fields caused an increase in pulse rate in the chick embryos. Normalization of pulse rate occurred 1.5 to 2.0 hr after exposure to UHF. The UHF parameters used did not generally disrupt the dynamics of developmental changes in pulse rate. However, exposure of 14-day embryos to UHF caused an increase in their pulse rate that was noticeable at hatching. (ATD)

26896 THE ROLE OF DIFFERENT BRAIN FORMATIONS IN ELECTROENCEPHALOGRAPHIC RESPONSES OF RABBITS TO A CONSTANT MAGNETIC FIELD AND TO ULTRAHIGH AND SUPERHIGH FREQUENCY ELECTROMAGNETIC FIELDS. Chizhenkova, R. A. (Inst. of Higher Nervous Activity and Neurophysiology, Moscow). Zh. Vyssh. Nerv. Deyateln. im I. P. Pavlova, 17: 313-21(1967). (In Russian).

EEG tests were run on the recticular formation of the midbrain, the posterior ventrolateral thalamic nucleus, and the posterior hypothalamus to provide information on the mechanics of EEG responses to a constant magnetic field, to ultrahigh and superhigh electromagnetic fields, and to ionizing radiation. EEG reactions of rabbits to one minute action of a constant magnetic field of 460 oersteds consisted basically of an increased number of spindles. EEG responses in the UHF field (wavelength 7.5 m, 30 v/m) and SHF field (wavelength 12.5 cm, power flux density 40 mW/cm^2) were characterized mainly by the appearance of slow high-amplitude waves that might be accompanied by an increased number of spindles. Unilateral ablation of the investigated formations did not hinder the appearance of EEG responses to the magnetic or electromagnetic fields and did not lead to asymmetry of the responses, after the disappearance of postoperative EEG changes. The results were compared with published data on the influence of ablation of these structures on the primary electrical responses of the cerebral cortex to ionizing radiation. It was concluded that the predominant action of the constant magnetic field and the electromagnetic fields of the investigated intensities on the central nervous system was direct and not reflex. It was, however, not possible to conclude that the mechanism of the development of EEG responses to the magnetic and electromagnetic fields really differed from responses to ionizing radiation, only that the EEG reactions to the constant magnetic field and the electromagnetic fields of the given intensities differed from previously described electrical reactions of the cerebral cortex to ionizing radiations. (ATD)

26897 EFFECTS OF SMALL DOSES OF RADIOACTIVE STRONTIUM ON THE RAT BONE MARROW. Stocke, T.; Oftedal, P.; Pappas, A. (Univ. of Oslo). Acta Radiol., Ther., Phys., Biol., 7: 321-9(1968).

Bone marrow cellularity in the rat was measured after injection of small amounts of Strontium-90. Reduced cellularity could be observed six and 12 weeks after injection of 0.0015 mu Ci/kg, leading to accumulated doses of 10 to 20 millirad. (auth) (Swed)

26898 ROLE OF LYSOZYME AND CHARACTER OF ANTIBODIES IN EXPERIMENTAL VIRAL INFECTION. Mestecky, J.; Medlin, J. (Inst. of Microbiology, Prague). Acta Virol. (Prague), 11: 206-15(May 1967).

Lysozyme concentration in rabbit serum increased in the course of infection by neurotropic vaccinia virus, but remained unchanged in the course of infection by Western equine encephalomyelitis (WEE) virus. The x irradiation of rabbits (500 R) or guinea pigs (300 R) caused a decrease in the level of lysozyme lasting for about 13 days. The level of lysozyme in lung macrophages was not markedly affected by irradiation, but the number of leukocytes decreased and the decrease lasted longer than that of the lysozyme level. After simultaneous irradiation and infection, irradiation effects predominated. Lysozyme in doses of 1, 10, 100, and 1000 μg/ml had no in vitro effect on the reduction of the number of plaques formed by neurotropic vaccinia virus in HeLa cell cultures. The addition of 1, 10, 100, or 1000 μg/ml had no effect on the 50% plaque inhibition titer of antivaccinia serum, from which lysozyme had been previously removed by adsorption onto bentonite. Lysozyme administered to rabbits before and during infection with dermotropic vaccinia virus did not affect the course of infection. Neutralizing and hemagglutination inhibiting antibodies showed the same kinetics and persisted for the whole period of the experiment. Early-appearing antibody was of the γM (19S) type, sensitive to 2-mercaptoethanol, and appeared as early as on the fifth day after infection, reaching its peak from the 10th to 15th day. The γG (7S) antibody appeared later (15th day), was resistant to 2-mercaptoethanol, and persisted for the entire period of the experiment. (BBB)

26899 MORPHOLOGY OF THE OVARIES IN MICE SUBJECTED TO TOTAL SINGLE X-IRRADIATION. Borovkov, A. I. Arkh. Patol., 30: No. 12, 31-6(1968). (In Russian).

The authors studied the morphology of the ovaries in hybrid mice (C 57 Bl × CBA)F_1, sacrificed 15 months after total single x irradiation in doses of 50 to 500 R. Normal ovarian structures were absent in the irradiated mice; as to nonirradiated mice, the usual age changes were revealed. Apart from tubular proliferations of the embryonic epithelium, there was a tubular-alveolar complex with hyperplasia in the irradiated animals; this complex was undoubtedly a paraovarian formation originating from the ovarian rudiment. Tubular elements were lined with the uni- and multistratal epithelium, in which ciliated and secreting cells were revealed constantly. The strata and nodules of the hyperplastic tissue were usually located in the area of the porta ovarii and among elements of the complex. Some of the tumors in the irradiated mice were classified as androblasts. The author presumes that radiation tumors in mice, primarily androblasts, develop from rudimentary formations of the ovary. (auth)

26900 CONCERNING PATHOLOGIC ANATOMY OF THE AFFECTION WITH ^{237}Np. Lemberg, V. K.; Levdik, T. I. (Inst. of Biophysics, Moscow). Arkh. Patol., 30: No. 12, 36-41(1968). (In Russian).

About 50% of rats died on the 2nd to 5th day after the intravenous injection of ^{237}Np in a dose of 1.5 mg per animal. Histological findings were the following: acute toxic dystrophy of the liver, necrotic nephrosis, marked circulatory disturbances. Early lesions were conditioned chiefly by chemical toxicity of the element. Microfocal nephrosclerosis and depression of osteogenesis were the most characteristic of a chronic period of the affection (1 to 12 months). Radiation action of the isotope acquired considerable significance in the etiology of a chronic period. A brief description of the isotope microdistribution in the most affected organs is presented. (auth)

26901 A STUDY ON THE UV FLUORESCENCE OF THE BONE MARROW CELLS IN THE OFFSPRINGS OF IRRADIATED ANIMALS. Vorobtsova, I. E.; Safronova, V. G. (Central Research Inst. of Roentgenology and Radiology, Leningrad). Tsitologiya, 11: 255-9(Feb. 1969). (In Russian).

Some changes were found to arise in the genital cells of irradiated animals which do not disappear in the course of a most complicated process of their posterity ontogenesis. These changes are manifested as a higher uv fluorescence of their somatic cells (myeloid tissue of the bone marrow). (auth)

26902 LOCALIZED IN VITRO IRRADIATION OF THE MOUSE GASTRULA. Benoit, Jean (Centre National de la Recherche Scientifique, Val-de Marne, France). Comp. Rend., Ser. D., 268: 371-4(Jan. 13, 1969). (In French).

Mouse embryos taken at 7.5 days were x irradiated in the axial region either in front of or behind the Hensen node. When these embryos were placed in culture for 24 to 48 hr in a liquid medium with colt serum base, they showed certain organization deficiencies that indicated the limits of the regulation capacity of the gastrula. (tr-auth)

26903 EFFECTS OF FAST NEUTRONS ON LIFE SPAN OF ERYTHROCYTES OF THE RABBIT AFTER LABELING WITH ^{51}Cr. Dantchev-Urbain, Monique; Dantchev, Dimitre; Benard, Henri (Academie Nationale de Medecine, Paris). Compt. Rend., Ser. D, 268: 103-6(Jan. 6, 1969). (In French).

Fast neutrons at doses between 200 and 800 rad cause an in vivo shortening of five to 15 days of the survival of erythrocytes in approximately 60% of rabbits irradiated and affecting selectively the youngest erythrocytes. (tr-auth)

26904 AN IMMEDIATE IRRADIATION EFFECT ON RESISTANCE OF RATS TO LOW TEMPERATURE. Phillips, Richard D.; Kimeldorf, Donald J. (Naval Radiological Defense Lab., San Francisco). J. Appl. Physiol., 24: 768-72(June 1968).

The effect of irradiation on the cold resistance of rats during the first 24 hr after x irradiation was studied, both the time course of the response and dose-response relation being evaluated. Survival time in the cold was the criterion used to determine the effect of irradiation on the resistance of rats exposed to a low environmental temperature. Irradiated rats (50 to 2000 rad) and their sham-irradiated littermate controls were placed in the cold (−17°C) at various times (30 min to 24 hr) after irradiation. A change in resistance was observed after irradiation with doses of 100 rad or more. Irradiation had a detrimental effect on the survival of rats exposed to low temperature at all times tested. The radiation-induced decrease in cold resistance was greater in groups tested early after irradiation than in groups tested at 16 or 24 hr postirradiation. The magnitude of the radiation effect was dose dependent. At doses greater than 100 rad, the median survival time of rats in the cold was inversely related to radiation dose. (BBB)

26905 EFFECT OF PRIOR CENTRIFUGATION ON RADIATION-INDUCED REACTIONS OF THE VESTIBULAR ANALYZER. Apanasenko, Z. I. pp 184-202 of Nekotoryye Voprosy Kosmicheskoy Neyrofiziologii. Moscow, Izdatel'stvo Nauka, 1967. (In Russian).

The study was conducted in guinea pigs, under observation 10 to 15 days prior to the experiment. One group of animals was subjected to a 15 min transverse acceleration at 8 G and three days later to a single total γ irradiation dose of 500 R at 200 R/min. Two other groups were subjected to acceleration or irradiation only. The animals were observed for 15 days thereafter. The functional state of the vestibular analyzer was evaluated according to electromyographic characteristics of the vestibular-tonic reflex in the extensor muscles of the hind leg induced by a 10 sec rocking motion. Immediately following reaction to an adequate stimulation of the vestibular apparatus, electric muscle activity decreased, and the post-irritation effect consisted of two phases, one of decreased and a second of increased myoelectric activity. For centrifugation only, this activity increased for three days, then decreased and reached normal values on the 15th day. For irradiation only, electrical activity declined and reached very low or zero values shortly before the animal's death. For the combined effect, bioelectric muscle activity was found to increase sharply after acceleration; this increase was maintained up to the time of irradiation after which it declined somewhat for two days, then increased again, decreased once more after the fifth day, and reached below normal values on the 15th day, shortly before the animal's death. The acceleration effect thus predominated, and the irradiation effect was seen only just before the animal's death. This effect was observed in all but one animal in which the radiation effect prevailed. It was concluded that the effect of the combined stress caused changes in the length of the latency and in the post-irritation period; in the majority of animals, the former decreased and the latter increased. Acceleration thus considerably alters the effect of radiation on electromyographic values; the former effect predominates, masking the radiation reaction almost to the time of the animal's death. Results were on the whole more uniform than for the combined action of vibration and radiation. In respect to peripheral blood values, weight curve, and clinical state and survival, no significant difference was detected between the combined effect and that of radiation. (ATD)

26906 DISTRIBUTION AND PROPERTIES OF LYSOSOMAL ENZYMES IN UNTREATED AND IN IRRADIATED MOUSE MAMMARY-GLAND CARCINOMAS. Paris, Jose E.; Brandes, David; Anton, Elsa (Univ. of Maryland School of Medicine, Baltimore. Johns Hopkins Univ., Baltimore. Baltimore City Hospitals). J. Nat. Cancer Inst., 42: 383-98(Mar. 1969).

The subcellular distribution of various lysosomal hydrolases was investigated in C3H mammary carcinomas before and after x irradiation, and the results were correlated with electron-histochemical findings. Homogenates from irradiated tumors showed an increase of total activities and a shift from sedimentable toward unsedimentable activities. These biochemical changes were accompanied by an increase in the number and size of lysosomes in tumor cells and a moderate infiltration of phagocytic elements. Cytochemically, the tumor cells revealed an enhancement of activity of the Golgi elements and a development of primary lysosomes as well as dense bodies and autophagic vacuoles. The observed behavior is compatible with the idea that an intracellular shift of hydrolases toward areas of cytoplasmic degradation is related to the injurious attack by ionizing radiation. (auth)

26907 LASER IRRADIATION OF THE ANTERIOR SEGMENT OF THE EYE: RABBIT EYES. Hallman, Vivienne L.; Perkins, E. S.; Watts, G. K.; Wheeler, C. B. (London Univ.). Exp. Eye Res., 7: 481-6(Oct. 1968).

Studies were made of the threshold energy levels that would cause damage to the ocular media and the iris of rabbit eyes and to investigate the possible therapeutic value of laser irradiation of the tissues of the anterior segment. Three types of laser were used: a continuous He–Ne laser, a ruby pulsed laser, and a continuous Ar laser. Both pigmented and albino rabbits were studied. Ruby lasers with power outputs of 230 and 800 mJ caused no detectable lesions in the transparent media of the eye but produced marked changes in the iris of pigmented animals. Repeated exposures were required to produce a hole in brown irises but a hole resulted from a single exposure in a blue iris. A 3-mW continuous Ar laser caused corneal edema after 1½ min exposure. The histological appearances of the ruby laser lesions on the iris are described. The darkening of the iris that occurred immediately after exposure was explained in terms of the pigment scatter seen in the histological sections. In iris, as in the posterior pigment epithelium, the light energy is preferentially absorbed, the chromatophores are shattered, and their melanin granules scattered into the anterior stroma, giving the brown appearance of the lesion. The energy absorbed and transmitted to the surrounding tissue causes it to become necrotic and eventually to degenerate. The characteristic lesion with severe damage to the pigment epithelium, less severe damage on the anterior surface, and relatively mild stromal damage, thus results. Apart from those in the pigment epithelium, no signs of regenerative processes were seen. Probably holes, once produced, are unable to heal, but while there is still a framework of stromal tissue left the pigment epithelium will continue to proliferate, thus accounting for the reduction in transillumination in the later stages of the lesion. (BBB)

26908 MODIFICATIONS OF THE CORTICOTROPHIC CELLS OF THE HYPOPHYSIS OF THE RADIOTHYROIDECTOMIZED EEL. Olivereau, Madeleine (Institut Oceanographique, Paris). Z. Zellforsch. Mikroskop. Anat., 90: 289-95(Aug. 15, 1968). (In French).

Eels were injected with ^{131}I in total doses of 750 μCi over two months or 2250 μCi over eight months and histologic studies were made of the pituitary gland. In the eels that were completely or subtotally radiothyroidectomized with repeated injections of high doses of ^{131}I, after two to eight months the histological picture of the adrenal glands suggested hypoactivity, as indicated by a nuclear and nucleolar atrophy. Simultaneously, in the pituitary gland, the corticotrophic cells were smaller and less granulated, with a finely vacuolated apical cytoplasm. The diameter of their nuclei was significantly reduced. It appeared that the adrenal response to thyroidectomy was, at least partly, mediated by the pituitary gland. As thyroxine treatment induced a stimulation of the hypophyso-adrenocortical system in the eel, and a decrease or disappearance of thyroidal hormones exerted a depressing effect, it seems that there was a synergy between the activity of the thyroid gland and the adrenal glands in this species, the hypophysis playing a role of mediator in these responses. (BBB)

26909 DIFFERENTIAL RADIOSENSITIVITY OF STATIONARY AND MIGRATORY PRIMITIVE CELLS IN THE BRAINS OF INFANT RATS. Altman, Joseph; Anderson, William J.; Wright, Kenneth A. (Massachusetts Inst. of Tech., Cambridge). Exp. Neurol., 22: 52-74(Sept. 1968).

Combined thymidine-^{3}H autoradiography and x irradiation of the heads of infant rats were undertaken to determine the differential radiosensitivity of different classes of immature cells (proliferating and nonproliferating, migratory, and stationary) in different brain regions. One group of animals was injected with thymidine-^{3}H immediately after 200 R irradiation and another, 24 hr before irradiation. All were killed at three days of age, six hr after irradiation and six or 30 hr after injection. In autoradiograms from the brains of unirradiated animals killed six hr after injection, the proportion of labeled cells, reflecting the regional rate of cell proliferation, was determined at several brain sites. The relative reduction in the rate of cell proliferation in irradiated animals was also established. In matched stained sections the proportion of pyknotic cells, reflecting rate of cell death, was determined in the same brain regions. Finally, pyknosis index/labeling index ratios were calculated to relate radiation-induced cell death to rate of cell proliferation at different loci. It was established that migrating cells and prospective migratory cells, whether mitotic or post-mitotic, are extremely radiosensitive, with a large proportion of them killed by exposure to 200 R. Relatively few of the stationary proliferating cells were killed with this dose. Stationary differentiating cells and mature cells were not visibly affected. These results suggest that damage to the cellular mechanisms that enable primitive cells to locomote, rather than damage to DNA, is the principal cause of cell death in the nervous system exposed to low-level radiation. (BBB)

26910 SENSITIVITY OF IMMATURE AND ADULT DOG BONE TO ACUTE AND CHRONIC IRRADIATION. McKelvie, Douglas Hugh. Davis, Calif., Univ. of California, 1968. 162p. Thesis.

An experiment was designed to determine the effects of continuous irradiation to cortical bone of beagles during the growth period. This was accomplished by the administration of 10 μCi ^{90}Sr/g Ca in the diet to four dams from three weeks' gestation through lactation, and to their 18 pups until sacrifice at 150 days of age. Controls (four dams and 16 pups) were treated similarly. Cumulative skeletal dose was about 2000 rads. One-half of the controls and one-half of the ^{90}Sr-fed pups each received approximately 2000 R x irradiation (140 R/week for 14 weeks) to the left hind limb from the stifle distally. Nine other dogs received x irradiation of 2000 R, 4000 R, and 6500 R at varying ages to the left hind limb to observe x-ray effect at a later age. Bones studied were the tibiae, femora, left metatarsals, and left humeri. Complete hematology and serum chemistry studies were also conducted. Other measurements included body weights and gross physical measurements of the bone at necropsy and from radiographs. Microradiography, microdensitometry, and tetracycline labeling of bone were also utilized. Dogs maintained on a diet containing 10 μCi ^{90}Sr/g Ca from birth show a weight gain the same as their controls' until weaning, after which time only the controls have a lag in rate of weight gain. During the growth period, animals maintained on food containing ^{90}Sr have increased serum values of bilirubin, total protein, calcium, inorganic phosphorus, alkaline phosphatase, serum glutamic oxalacetic transaminase, and α_2 globulin. Values of blood urea nitrogen and serum glutamic pyruvic transaminase are decreased. Neutrophil and lymphocyte numbers are depressed in ^{90}Sr-fed beagles. Packed cell volumes were similar in ^{90}Sr-fed dogs and controls. X irradiation of the tibia at 140 R/week for 14 weeks, beginning at 50 days of age, results in 10% depression in length of that bone in control and ^{90}Sr-fed beagles. Administration of 6500 R at 500 R/week resulted in cessation of tibial growth. X irradiation of a bone caused a decrease in linear growth rate compared to controls, only if the bones were from ^{90}Sr-fed dogs. Net bone volume (bone less marrow cavity) was greater in ^{90}Sr-fed beagles than in controls. Beagles fed ^{90}Sr had a smaller medullary index than controls. Irradiation increased the MI of ^{90}Sr-fed dogs' bones by depressing lateral growth. Microradiographs of bones from ^{90}Sr-fed dogs generally revealed smaller percentages of hypomineralized osteons and resorption cavities and increased percentage of nonactive osteons. Bone density in ^{90}Sr-fed beagles is greater than that in controls. Continuous β irradiation in uniformly labeled bone has a differential effect on osteoclastic and osteoblastic activity, resulting in a greater depression of osteoclasis. The effect of continuous β irradiation to bone uniformly labeled with ^{90}Sr is a quantitative one; the effect of x irradiation in acute fractionated doses is qualitative. (TSS) (auth) (Disser. Abstr.)

26911 COMPARATIVE HEMATOPOIETIC CYTOKINETICS IN X-RAY OR GAMMA-NEUTRON IRRADIATED RATS. Baum, S. J.; Wyant, D. E.; Vagher, J. P. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Amer. J. Physiol., 216: 582-8(Mar. 1969).

In polycythemic rats, the response of hematological stem cells to erythropoietin, as measured by ^{59}Fe uptake in the progeny of these cells, was utilized as a measure of the effects of irradiation from either x rays or mixed γ-neutron radiation. It was observed that stem cell injury increased significantly with increasing radiation dose as expressed in the first rapid recovery phase. Although recovery responses were dose dependent, they were independent of the type of radiation and, in general, the RBE of γ-neutron radiation appeared to be one. A significant decrease in the initial recovery response was observed for most days in animals subjected to a repeated dose of 200 to 250 rads after a 90-day rest period. The data suggest that the post-irradiation physiological adjustments in the rat initiated by recovery and subsequent cellular proliferation result in the early abortive cellular rise and its termination as well as in the following oscillations in cellular production. (auth)

26912 THE EFFECTS OF GAMMA IRRADIATION ON THE POSTNATALLY DEVELOPING CANINE CEREBELLAR CORTEX. I. EFFECTS OF SINGLE SUBLETHAL EXPOSURES. Phemister, Robert D.; Shively, James N.; Young, Stuart (Colorado State Univ., Fort Collins). J. Neuropath. Exp. Neurol., 28: 119-27(Jan. 1969).

Puppies irradiated as neonates can survive much higher doses than those exposed either prenatally or at greater ages. Some neonatally exposed puppies that survive higher exposures develop neurologic signs, including tremor of the head and trunk, ataxia, weakness of the hind quarters, and hypermetria of all four limbs. The canine cerebellum appears to be both immature and radiosensitive shortly after birth. The radiosensitivity of the neonatal canine cerebellar cortex was studied in beagle puppies by qualitative and quantitative histologic methods. Morphologic effects produced in the cerebellum by various single, whole-body sublethal exposures to γ radiation (85, 170, 325, or 500 R) on the 2nd postnatal day were evaluated 70 days after exposure. Highly significant quantitative differences between control and irradiated dogs were demonstrated in the mean width of various cortical layers at each of the four exposure levels. Striking histologic malformations were observed in the cerebellum following either 325 or 500 R, but such changes were not evident in dogs that received 85 to 170 R. The malformations at the higher doses consisted principally of ectopic clusters and poorly defined rows of granule cells in the molecular layer, and of localized areas of obviously reduced cell numbers in the internal granular layer. (BBB)

Man

Refer also to abstracts 26811 and 26859.

26913 (A-AC-82/G/L-1261) CONDITION OF THE NERVOUS SYSTEM IN CHILDREN A LONG TIME AFTER IRRADIATION. Tereshchenko, N. Ya. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow). 1968. 17p. (In Russian). Dep.

In view of the increased tendency to use x-ray therapy in pediatric practice, the published literature was analyzed to evaluate the effect of ionizing radiation on the nervous system of children. It was observed many years ago that children are especially sensitive toward radiation that affects the growth and the brain functions. The dependence of changes in the central nervous system on the total dose to which the children were exposed was based on the examination of the aftereffects of x-ray treatment for epilation and tumor therapy. Evaluation of the correlation is rendered difficult by differences in the conditions of the exposure, absence of neurological data prior to irradiation, lack of follow-up and limited pathomorphological confirmation. Even so, it could be established that local action at the head after exposure to 6000 to 10,000 R results in deep injury to the brain. A total dose between 2000 and 4000 R causes scattered organic microsymptoms which may be detected by encephalopathy. Doses of about 1500 to 2000 R create asthenic and astheno-vegetative injuries. Functional changes in the nervous system appeared at local exposures up to 1000 R. The age of the patient appears to be a very important factor in the gravity of the injury; the younger the child, the larger the probability of radiation injury. (review article, 88 references). (TTT)

26914 LATE POST RADIATION CHANGES IN THE LARYNX, PHARYNX, OESOPHAGUS, AND THE TRACHEA. Kapur, T. R. (Univ. of Cambridge, Eng.). J. Laryngol. Otol., 82: 447-57 (May 1968).

Late post-radiation changes are described in five patients who had been treated with x radiation for various benign and malignant conditions in the neck area. Benign strictures of the esophagus and the trachea and laryngeal stenosis occurred in two cases after 21 to 26 yr. Malignant changes occurred in three cases after 26 to 34 yr. Etiological factors are postulated. (M.M.B.)

26915 HISTORY OF THE EXPOSURE OF MINERS TO RADON. Holaday, Duncan A. (Public Health Service, Cincinnati). Health Phys., 16: 547-52(May 1969).

Many underground mines, tunnels or caves have measurable amounts of the radioactive gas ^{222}Rn, a member of the uranium family which diffuses through rock and concentrates in underground openings. The primary sources of radiation exposure to persons entering such underground areas are the short-lived daughters of radon: ^{218}Po, ^{214}Pb, ^{214}Bi, and ^{214}Po. These elements diffuse rapidly and attach to the first surface encountered. Either the free atoms or the particulates to which they are attached are inspired and largely retained in the respiratory tract. The effects of exposure of miners to radon daughters have been observed for many years although it is only in the last 40 yr that the relationship between such exposure and an increased incidence of lung cancer has been suspected, and only in the last 5 yr that a cause-effect relationship has been clearly demonstrated. The documented instances have occurred in the Schneeburg mining district in Germany, the Joachimsthal district of Czechoslovakia, in fluorspar mines in Newfoundland, in American uranium mines, and probably in a group of American metal miners. In all instances the medical and environmental data are not as complete or detailed as could be desired. (auth)

26916 MORTALITY OF URANIUM MINERS IN RELATION TO RADIATION EXPOSURE, HARD-ROCK MINING, AND CIGARETTE SMOKING: 1950 THROUGH SEPTEMBER 1967. Lundin, Frank E. Jr. (National Inst. of Health, Bethesda, Md.); Lloyd, J. William; Smith, Elizabeth M.; Archer, Victor E.; Holaday, Duncan A. Health Phys., 16: 571-8(May 1969).

A mortality study was made of a group of 3414 white underground uranium miners. There were 398 deaths observed versus 251 deaths expected on the basis of rates for the white male population of the area. Violent deaths (120 versus 50.5 expected) and malignant neoplasms of the respiratory system (62 versus 10 expected) largely accounted for the excess. Most of the respiratory cancer deaths occurred 10 or more years after the individual first mined uranium. No excess occurred in the first 5 yr after start of mining. The person years of followup were divided into six cumulative exposure levels. At each level of estimated radiation exposure a significant excess of respiratory cancer was observed. Beginning with the 840 to 1799 WLM category, the excess of respiratory cancer deaths was markedly progressive with increasing exposure. Below 840 WLM the excess occurred equally among three exposure groups. Prior hard-rock mining had little overall effect on lung cancer mortality, but might have contributed to the excess among the two lowest exposure categories. It is estimated that smoking uranium miners experienced an excess of lung cancer 10 times greater than did non-smoking miners. While smoking alone could not explain the marked excess of lung cancer, the data suggested that uranium miners should not smoke. (auth)

26917 EPIDEMIOLOGY OF LUNG CANCER AMONG URANIUM MINERS. Donaldson, Alan W. (Dept. of Health, Education, and Welfare, Washington, D. C.). Health Phys., 16: 563-9(May 1969).

The occurrence of lung cancer among uranium miners and other types of miners in Europe and the United States was studied. A clear association exists between cumulative exposure to short-lived radon daughters and a higher than expected incidence of lung cancer among the miners. The significance of epidemiological data in relation to the safety of the work place is discussed. (auth)

26918 HEMATOLOGIC CHANGES IN THE TREATMENT OF THYROTOXICOSIS AND CANCER OF THE THYROID GLAND WITH RADIOACTIVE ^{131}I. Nemec, J.; Neradilova, M.; Zamrazil, V.; Vohnout, S. (Vyzkummy Ustav Endokrinologicky, Prague). Cas. Lek. Cesk., 107: 742-8(June 14, 1968). (In Czech).

Thyroid carcinoma patients given 50 to 400 mCi of ^{131}I showed a slight rise in their lymphocyte count on the second day after treatment. This was followed by a drop, that leveled off after a week and then remained constant for the next two weeks. At the fourth week there was another drop except in the lowest-dose group. The neutrophil picture was similar except that the second-day rise was higher. Thyrotoxicosis patients similarly treated showed little change in the lymphocyte count, but the neutrophil count was slightly low six weeks after treatment. Administration of prednisone did not affect the above-mentioned changes, but thyrostatic agents administered before the ^{131}I was given had a slight positive effect. (TTT)

26919 BONE CHANGES IN OSTEORADIONECROSIS: A REVIEW. Pappas, Gus C. (Ohio State Univ., Columbus). Oral Surg., Oral Med., Oral Pathol., 27: 622-30(May 1969).

Microscopic studies of irradiated bone reveal definitive histopathologic changes. Osteoradionecrosis may develop at any time from a few weeks following therapy to as late as 10 yrs after irradiation. There are some radiographic findings that are significant, and these reveal the effects of irradiation on bone. In most instances, however, bone appears to be normal radiographically, thus making it impossible to evaluate its relative viability through radiographic osseous changes until the beginning of sequestration. The complexities of radiography as applied to bone changes in osteoradionecrosis are discussed. (auth)

26920 DISTRIBUTION, RETENTION, AND LATE EFFECTS OF THORIUM DIOXIDE. Conference held at New York, April 20, 21, and 22, 1966. Weyer, Edward M. (ed.). Ann. N. Y. Acad. Sci., 145: 523-858(Dec. 11, 1967). (CONF-660422).

A series of 37 papers are presented that are part of a conference held in April, 1966 on the effects, body distribution, dosimetry, and retention of colloidal thorium dioxide in man and animals.

Separate abstracts were prepared on 34 of the papers, all but three introductory papers on the history, diagnostic use, and manufacture of Thorotrast. (M.M.B.)

For abstracts of individual papers see: 26648, 26666–26669, 26772, 26791–26794, 26881–26886, and 26921–26938.

26921 FOLLOW-UP OF THORIUM DIOXIDE PATIENTS IN THE UNITED STATES. Telles, Norman C. (Public Health Service, Rockville, Md.). Ann. N. Y. Acad. Sci., 145: 674-5 (Dec. 11, 1967).

From Conference on Distribution, Retention, and Late Effects of Thorium Dioxide, New York. See CONF-660422.

The Division of Radiological Health of the United States Public Health Service is interested in establishing a roster of Thorotrast recipients in the United States in order to obtain as much data as possible about the response of man to chronic low-dose ionizing radiation. The Thorotrast subjects represent a unique opportunity with regard to dose-effect information in man. (M.M.B.)

26922 LATE EFFECTS OF THOROTRAST ON THE LIVER AND SPLEEN, AND THEIR EFFERENT LYMPH NODES. da Silva Horta, J. Faculty of Medicine, Lisbon). Ann. N. Y. Acad. Sci., 145: 676-99(Dec. 11, 1967).

From Conference on Distribution, Retention, and Late Effects of Thorium Dioxide, New York. See CONF-660422.

The histopathological effects of Thorotrast five to 31 yr after injection into patients in Portugal are described. Materials were obtained from autopsy, biopsy, or splenectomy. Fibrosis of the liver and spleen and efferent lymph nodes was found. The most frequent liver tumor was the hemangioendothelioma. Cases with reticulum cell sarcoma, hepatoma and cholangioma, and carcinoma of the extrahepatic bile ducts are described. Morphological observations having no relation to the other Thorotrast effects are also described. (M.M.B.)

26923 TWO CASES OF CARCINOMA AFTER THOROTRAST ADMINISTRATION. Kahn, Helena Levy (Inst. of Anatomical Pathology, Lisbon). Ann. N. Y. Acad. Sci., 145: 700-17(Dec. 11, 1967).

From Conference on Distribution, Retention, and Late Effects of Thorium Dioxide, New York. See CONF-660422.

Thirty-three cases from the literature on Thorotrast-related liver carcinomas are reviewed. In addition the autopsy and microscopic observations on two other cases are presented in detail. One was a cholangiocarcinoma found 28 yr after Thorotrast was injected for cerebral angiography. The other was a mucous adenocarcinoma of the common hepatic duct found 26 yr after injection of Thorotrast for portography. In both cases, the tumor originated in the vicinity of a large nodular deposit with the microscopic characteristics of a Thorotrast granuloma. (M.M.B.)

26924 LATE EFFECTS OF THORIUM DIOXIDE ON THE LIVER OF PATIENTS IN SWEDEN. Dahlgren, Sven (Karolinska Sjukhuset, Stockholm). Ann. N. Y. Acad. Sci., 145: 718-23 (Dec. 11, 1967).

From Conference on Distribution, Retention, and Late Effects of Thorium Dioxide, New York. See CONF-660422.

Ten cases of malignancy of the liver after injection of Thorotrast were reported in Sweden. The latent periods were from 19 to 27 yr. They include an adenocanthoma, three liver cell carcinomas, two undifferentiated carcinomas, a hemangioendothelioma and three adenocarcinomas. Four of these cases had liver fibrosis and five additional Thorotrast patients with liver cirrhosis were observed. Three cases had alterations in the pancreas. (M.M.B.)

26925 RECOGNITION OF RADIATION-INDUCED LATE BONE MARROW CHANGES. Finch, Stuart C. (Yale Univ. School of Medicine, New Haven). Ann. N. Y. Acad. Sci., 145: 748-54(Dec. 11, 1967).

From Conference on Distribution, Retention, and Late Effects of Thorium Dioxide, New York. See CONF-660422.

The problems involved with associating hematologic disease with radiation exposure are discussed. Reports in the literature that describe the effects of low dose or chronic radiation exposure are reviewed. 64 references. (M.M.B.)

26926 LEUKEMIA AND OTHER HEMATOLOGICAL DISEASES AFTER THOROTRAST. Faber, Mogens; Johansen, Charles (Finsenlaboratory, Copenhagen). Ann. N. Y. Acad. Sci., 145: 755-8(Dec. 11, 1967).

From Conference on Distribution, Retention, and Late Effects of Thorium Dioxide, New York. See CONF-660422.

The effects of the injection of both normal and α-enriched Thorotrast on the bone marrow and hematological picture of rabbits are described. Seven cases of Thorotrast-associated leukemia and five cases of other blood diseases associated with Thorotrast are discussed. (M.M.B.)

26927 CHROMOSOMAL ABERRATIONS IN THORIUM DIOXIDE PATIENTS. Fischer, P.; Golob, E.; Kunze-Muehl, E.; Muellner, T. Ann. N. Y. Acad. Sci., 145: 759-66(Dec. 11, 1967).

From Conference on Distribution, Retention, and Late Effects of Thorium Dioxide, New York. See CONF-660422.

Twenty patients who were known to have received Thorotrast about 19 to 27 years previously, and whose residual body burden was measured by whole-body counting, were examined for the presence of chromosome aberrations in dividing cells from short-term peripheral blood cultures. Aberrations were present in 19 of the 20 persons examined. The one patient in whom no aberrations were observed had received Thorotrast for retrograde pyelography. His residual body radioactivity was very low. Statistical tests of the data for evidence of a dose-effect relationship revealed a significant correlation between the number of chromosome breaks and the radioactive body-burden. The high rate of chromosome breakage, and its possible relationship to radiation-induced carcinogenesis in these cases is briefly discussed. (auth)

26928 LEUKEMIA AND OTHER FATAL BLOOD DYSCRASIAS IN THORIUM DIOXIDE PATIENTS. Abbatt, John D. (Dept. of National Health and Welfare, Ottawa). Ann. N. Y. Acad. Sci., 145: 767-75(Dec. 11, 1967).

From Conference on Distribution, Retention, and Late Effects of Thorium Dioxide, New York. See CONF-660422.

The history of hematologically oriented epidemiological studies on Thorotrast is briefly reviewed, and the sources and nature of recent data from current surveys are assembled. Fatal blood diseases were reported as being due to: leukemia and a group of non-leukemic but fatal blood dyscrasias, the majority of which are aplastic anemia. These conditions occur with a long latent period of 15 to 17 yr after Thorotrast injection. The contrast between external radiation leukemias, latent period of 5 to 7 yr past exposure and internal radiation (from internal emitters), latent period 15 to 17 yr, is noted. The reason for this difference is not known but is probably related to quality factors of radiation and to dose rate. It is suggested that the miscellaneous blood dyscrasia deaths are in the main misdiagnosed and are probably aberrant forms of leukemia. It is also concluded that long-term low-dose radiation, as opposed to acute irradiation, does not produce hypoplasia—and aplastic-anemia. This interpretation of available data is consistent with both the ankylosing spondylitic data as well as that derived from Thorotrast studies. The question of risk—or hazard evaluation—particularly for extrapolation purposes is briefly discussed and it is concluded that: a combined and controlled collaborative study is necessary to arrive at a valid estimate of the incidence of long-term hematological effects after Thorotrast; physical dosimetry is complex but will probably be adequate for such a study; and diagnostic criteria must be established and coordinated within such a study. In future extrapolation to other situations, Thorotrast data suggest that the development of leukemia in people with appreciable ^{90}Sr burdens may be just as or more likely than the development of osteogenic sarcoma. Such developments will only occur after long latent periods of 10 to 15 yr or more. (auth)

26929 EFFECTS OF COLLOIDAL THORIUM DIOXIDE EXTRAVASATES IN THE SUBCUTANEOUS TISSUES OF THE CERVICAL REGION IN MAN. da Silva Horta, J. (Faculte of Medicine, Lisbon). Ann. N. Y. Acad. Sci., 145: 776-85(Dec. 11, 1967).

From Conference on Distribution, Retention, and Late Effects of Thorium Dioxide, New York. See CONF-660422.

Ninety-one cases of Thorotrast granulomas were found in an epidemiological survey in Portugal. Most of these were in the neck where the Thorotrast was injected for cerebral angiography. Among these cases five malignant neoplasms were found on the edge of the granulomata. The results of the histological examination of autopsy, biopsy, and surgical material are presented. (M.M.B.)

26930 EFFECTS OF LOCALLY DEPOSITED COLLOIDAL THORIUM DIOXIDE. Dahlgren, Sven (Karolinska Sjukhuset, Stockholm). Ann. N. Y. Acad. Sci., 145: 786-90(Dec. 11, 1967).

From Conference on Distribution, Retention, and Late Effects of Thorium Dioxide, New York. See CONF-660422.

Thirteen patients observed in Sweden with alterations of the subcutaneous tissues of the neck region following extravascular injection of thorium dioxide are described. Ten of these cases had fibrous tissue (Thorotrastoma), two had neurofibrosarcomas, and three necrotic ulcerations of the pharynx. The effects of locally deposited colloidal thorium dioxide are described in four other patients, two of which had Thorotrostomas and two squamous-cell carcinomas. (M.M.B.)

26931 HISTOPATHOLOGIC STUDY OF INTRADERMAL PLUTONIUM METAL DEPOSITS: THEIR CONJECTURED FATE. Lushbaugh, C. C. (Oak Ridge Inst. of Nuclear Studies, Tenn.);

Cloutier, Roger J.; Humason, Gretchen; Langham, Julia; Guzak, Steven. Ann. N. Y. Acad. Sci., 145: 791-7(Dec. 11, 1967).

From Conference on Distribution, Retention, and Late Effects of Thorium Dioxide, New York. See CONF-660422.

Autoradiographic and histologic study of eight dermal lesions, caused by accidentally implanted particles of metallic plutonium, revealed that a minute granuloma resulted in which after four or more yrs collagenous degeneration and liquefaction occurred. A comparison of the lesions with granulomatous and fibrotic lesions induced by Thorotrast suggested that softening of the granuloma in the thorium cases was more likely due to the chronic effect of the radiation exposure of the blood vessels than upon the collagen fibers themselves. The breakdown of collagen fibers around plutonium deposits, however, seems to be related to the relatively enormous dose rate to which these fibers are exposed. (auth)

26932 PERITONEAL HEMANGIOENDOTHELIOMATOSIS AFTER SALPINGOGRAPHY WITH THOROTRAST. Casper, Julian (Beilinson Hospital, Petah-Tiqva, Israel). Ann. N. Y. Acad. Sci., 145: 798-805(Dec. 11, 1967).

From Conference on Distribution, Retention, and Late Effects of Thorium Dioxide, New York. See CONF-660422.

A patient who had received Thorotrast for salpingography 14 yr previously was found to have diffuse hemangioendotheliomatosis of the peritoneum. Bilateral salpingo-oophorectomy was performed and biopsy specimens taken from the peritoneal serosa of the intestines and the parietal serosa. Hemorrhagic ascites was found and recurred after surgery suggesting that the lesion was proliferating and malignant. The histopathology of materials obtained by biopsy and surgery is described. (M.M.B.)

26933 TUMORS OF THE KIDNEY FOLLOWING RETROGRADE PYELOGRAPHY WITH COLLOIDAL THORIUM DIOXIDE. Wenz, W. (Univ., Heidelberg). Ann. N. Y. Acad. Sci., 145: 806-10(Dec. 11, 1967).

From Conference on Distribution, Retention, and Late Effects of Thorium Dioxide, New York. See CONF-660422.

Up to the present, 24 malignant Thorotrast tumors of the kidney have been described following retrograde pyelography. The major causes for the retention of the contrast medium in the kidneys are: reflux, hydronephrosis, and out-flow obstruction. The relatively long latent period of 27 yrs in the mean was put down to the very small amount of retained Thorotrast. The malignant tumors were found practically exclusively in kidneys that gave rise to ill-defined renal complaints due to chronic inflammatory changes and granulomas. There was a quantitative relationship between tumor incidence, latent period, and dosage of the administered Thorotrast. (auth)

26934 FOLLOW-UP STUDY OF PORTUGUESE PATIENTS GIVEN THORIUM DIOXIDE IN THE PERINASAL SINUSES. Cayolla da Motta, Luiz A. C. R. (Ministry of Health and Welfare, Lisbon). Ann. N. Y. Acad. Sci., 145: 811-16(Dec. 11, 1967).

From Conference on Distribution, Retention, and Late Effects of Thorium Dioxide, New York. See CONF-660422.

A survey, begun in 1961 and still in progress, comprises 177 patients who received intranasal instillations of Thorotrast for diagnostic purposes. Seventeen died before March 1966, but in none of these cases could death be attributed to the Thorotrast. None of the 177 patients have shown any local or general side effects of the drug. This may have been attributed to the fact that in these cases the Thorotrast was never allowed to stay in the perinasal sinuses for more than six days. (M.M.B.)

26935 FOLLOW-UP STUDY OF THORIUM DIOXIDE PATIENTS IN PORTUGAL. da Silva Horta, J. (Faculty of Medicine, Lisbon); Cayolla da Motta, Luiz. Ann. N. Y. Acad. Sci., 145: 830-42(Dec. 11, 1967).

From Conference on Distribution, Retention, and Late Effects of Thorium Dioxide, New York. See CONF-660422.

Provisory results (up to March, 1966) of a follow-up study of more than 1000 patients who had received Thorotrast in Portugal are presented. The main type of pathological effects were found to be local fibrosis, diffuse fibrosis of the main deposit organs such as liver, malignant granulomata, other malignant tumors such as hemangioendotheliomata, leukemias and aplastic anemias, and disproteinemia. (M.M.B.)

26936 THORIUM DIOXIDE PATIENTS IN DENMARK. Faber, Mogens (Finsenlaboratory, Copenhagen). Ann. N. Y. Acad. Sci., 145: 843-8(Dec. 11, 1967).

From Conference on Distribution, Retention, and Late Effects of Thorium Dioxide, New York. See CONF-660422.

A group of 1001 patients in Denmark who were injected intraarterially with Thorotrast for cerebral arteriography (except two who were injected differently) were subject to a follow-up investigation initiated in 1949. Causes of death and incidence of cancers are being recorded for these patients. (M.M.B.)

26937 PRELIMINARY REPORT FROM BOSTON ON THE FOLLOW-UP OF PATIENTS WITH THORIUM DIOXIDE DEPOSITS. Janower, Murray L.; Sidel, Victor W.; Flynn, M. Jean (Massachusetts General Hospital, Boston). Ann. N. Y. Acad. Sci., 145: 849-52(Dec. 11, 1967).

From Conference on Distribution, Retention, and Late Effects of Thorium Dioxide, New York. See CONF-660422.

Approximately 270 patients received thorium dioxide for cerebral arteriography at two institutions in Boston, Mass. Preliminary follow-up has been completed on the 153 patients treated at the Massachusetts General Hospital; of these, 61 are still alive and 92 are dead. A total of five tumors, three in the living and two in the dead groups, thought to have developed since the arteriography, were uncovered. Plans for physical, laboratory, x ray, radiation dosimetry, and pathological examination of the patients are presented. (auth)

26938 LATE EFFECTS OF THOROTRAST IN CEREBRAL ANGIOGRAPHY. Blomberg, R.; Larsson, L. E.; Lindell, B.; Lindgren, E. (National Inst. of Radiation Protection, Stockholm). Ann. N. Y. Acad. Sci., 145: 853-8(Dec. 11, 1967).

From Conference on Distribution, Retention, and Late Effects of Thorium Dioxide, New York. See CONF-660422.

A follow-up study was performed on part of a total material of about 1000 patients who received Thorotrast injections during the years 1932 to 1947. Twelve patients, half of the number with extravascular deposits, developed severe late complications at the site of injection. Nine cases of hepatic malignancy were found, the incidence apparently being related to the amount of Thorotrast injected. (auth)

26939 INTESTINAL COMPLICATIONS AFTER GYNECOLOGIC RADIOTHERAPY. Claus, H. G. (Univ., Mainz). Roentgen Bl., 19: 386-98(July 1966). (In German).

The frequency, nature, and severity of intestinal lesions that appear after radium implant γ and external x radiotherapy of ovarian and other types of gynecological tumors are evaluated and discussed. Results of a follow-up study of 200 patients are reported. (BBB)

26940 COMMENTS ON X-RAY ARTICLE. Goulding, Peter C. J. Calif. State Dent. Ass., 44: 236-7(June 1968).

Certain factual, scientific statements are made in answer to a misleading popular article on hazards of x rays in dentistry. No death or any serious injury resulting to a patient from a dental radiographic examination has ever been reported. The use of high speed film produces radiographs with less than $^1/_{10}$ the incident skin dose used in 1940. The average exposure to the gonadal area from a complete mouth radiographic examination using modern equipment and techniques is about the same as that received in a day from ambient radiation. Dentists, who are potentially exposed to many times the radiation received by an individual dental patient should have a higher death rate than the public. Surveys conducted on the cause of deaths of dentists, compared to the cause of death of the average male, showed no such hazard during the past 30 yr. Many of these dentists worked with x-ray machines when the amount of radiation required per film was 15 to 50 times that required today with fast film. Radiography is a potent diagnostic tool and should be used selectively, based on patient need and professional judgment. Modern dental radiographic examinations made with modern equipment and technics are safe. (BBB)

26941 PRENATAL RADIATION EXPOSURE. Med. J. Aust., 1: 418-19(Mar. 9, 1968).

Results of the Oxford Survey of the frequency of childhood malignancies attributable to prenatal x-ray exposure are described and discussed. The survey involved a study of 1299 deaths from malignant disease in children under 10 yr old, and of an equal number of paired healthy controls. There was an excess of cases of prenatal x-ray exposure among the children who died of juvenile cancer when compared with the control series. Between 1953 and 1955, 6 or 7% of juvenile cancer was due to this cause. All types of juvenile cancer, including leukemia, were equally involved. The survey now covers 6347 deaths from malignant conditions in children under 10 yr of age, and data for the complete first 10 yr of life are available for the cohorts born between 1952 and 1956. These comprise 75% of all relevant notified deaths in England, Wales, and Scotland during the years under review. The report showed that the risk at birth that a child, not exposed to radiation in utero, would develop cancer before the age of 10 yr was 1 to 1200. The figures showed a steep rise in the use of obstetric radiography from 1946 to a peak in 1954 to 1956, followed by a sharp fall to 1959. The fall since 1956 probably reflected a more conservative attitude towards obstetric radiography. There was one death from radiogenic juvenile cancer for every 12,800 births; within the same group of births there would have been not less than 720 perinatal fatalities. Timely use of obstetric radiography might have avoided some of these. The use of radiography in obstetrics must ultimately depend on the judgement of the individual doctor. (BBB) (TSS)

26942 MICROWAVE RADIATION HAZARDS TO MAN. Groot Wesseldijk, A. T. Tijdschr. Soc. Geneesk., 45: 760-8(Oct. 27, 1967). (In Dutch).

Introductory considerations on applications and physical properties of microwave radiation were given and the biological effects were examined. Readily absorbed by the body, microwaves can lead to local or general hyperthermia. Absorption increases in direct proportion to time, power density and frequency, and power of penetration follows similar laws. Discussion of total body irradiation was followed by a section on local hyperthermia (cataract formation, effects on the testicles, hyperthermia due to resonance phenomena or to passing from less absorbent to more absorbent tissue). Considerations on permissible power density, safety zones and other protective means were presented. (CIS)

26943 IMMUNOLOGIC STUDIES WITH THYROID DISEASES AND THEIR SIGNIFICANCE FOR NUCLEAR MEDICINE. Uthgenannt, H. (Medizinische Akademie, Luebeck). Fortsch. Med., 85: 441-4(June 8, 1967). (In German).

Factors that affect development of hypothyroidism after ^{131}I therapy are discussed. Hypothyroidism is rarely observed after treatment of diffuse euthyroid goiter, but rates of appearance of hypothyroidism after treatment of hyperthyroidism were reported to be as high as 29% within 10 yr after ^{131}I treatment. Fractionation of the ^{131}I treatment was suggested in order to reduce the incidence of post-treatment hypothyroidism. In hyperthyroidism without antibody formation early hypothyroidism is not observed after ^{131}I therapy, and evidence available so far indicates that hypothyroidism also is not observed at late intervals after ^{131}I therapy. In hyperthyroidism with antibody formation the frequency of hypothyroidism after ^{131}I therapy with an average dose of 7000 R/g is as high as 20%. Of all hyperthyroid patients, the hypothyroid incidence after ^{131}I therapy was about 9.4%. In hyperthyrodism without antibody formation ^{131}I therapy produced euthyroidism in 90% of the cases, with a single dose, but with a high high antibody titer, only 30% became euthyroid after ^{131}I therapy. (BBB)

26944 HISTOPATHOLOGIC STUDY OF THE EFFECTS OF SOLAR RADIATION ON THE SKIN AND ITS RELATIONSHIP TO CARCINOMA. Sirsat, M. V.; Shrikhande, Sumati S. (Tata Memorial Hospital, Bombay). Indian J. Cancer, 4: 185-93(June 1967).

Carcinoma of the skin comprises 20% of all cancers found in India. Incidence of cutaneous carcinoma in Parsees was found to be higher than among other Indians. In Western countries carcinoma of the skin makes up 10 to 12% of all cancers but in Australians its incidence is 60%. This very high incidence in Australians is attributed to exposure to uv radiation of the solar spectrum and to the lack of protective pigments in the skin. Observations were made on changes produced in the epidermis and dermis as the result of exposure to the uv radiation in sunlight and to assess the role of melanin pigment in carcinoma of the skin in fair-skinned and dark-skinned individuals. Sixty basal-cell carcinomas and 46 squamous-cell carcinomas were examined. The frequency of squamous-cell carcinoma was correlated with hyperkeratosis and abundant melanin pigment. It could not be correlated with any dermal changes. Squamous-cell carcinoma seems to be related to absorption of uv rays by epidermis, with screening of the dermis because of hyperkeratosis and increased melanin pigment. It is concluded that sunlight, especially its uv component, is a major cutaneous carcinogen. (BBB) (TSS)

26945 TREATMENT OF BLADDER ULCER AFTER RADIUM AND X IRRADIATION OF CERVICAL CANCER. Frick, J.; Hittmair, A. (Univ., Innsbruck). Urol. Int., 22: 429-34(1967). (In German).

Limits on tolerance doses that may produce irradiation ulcers of the urinary bladder and methods of treatment are discussed. Usually bladder ulcers result from combined injury from doses of Ra γ and x irradiation amounting to more than 6000 to 7000 R, and from urinary tract infections or bladder mucosa inflammation. In 77% of patients, the time of appearance of the ulcers ranges from 2 to 3 yrs after irradiation, but the interval may be less if the dose given is high, or it may be increased if the dose given is relatively low. Symptoms may include dysuria, hematuria, polyuria, and suprapubic pain. Effective treatment of vesical ulcers includes use of antibiotics, cortisone, analgesic-antispasmolytic drugs, and immobilization of the patient. If incrustations occur, these must be removed. As many as 87% of the cases of vesical ulcers can be healed within the first yr, and most can be healed by two yrs. The cases should be followed up for at least one yr in order to treat any worsening that may appear. (BBB)

26946 CHRONIC RADIATION NEPHRITIS AFTER EXPOSURE IN UTERO. Schaerer, K.; Muehlethaler, J. P.; Stettler, M.; Bosch, H. (Kantonsspital, Aarau, Switzerland). Helv. Paediat. Acta, 23: 489-508(1968).

The case history of a child is presented who was exposed to large doses of x rays in utero and later developed signs of progressive renal failure, that was ascribed to chronic radiation nephritis. Besides the clinical and anatomical details of the nephropathy some other features of fetal radiation injury are discussed. The mother of the patient had Hodgkin's disease from the age of 25, and was treated with x rays intermittently for a total dose of 18,600 R over the cervical, axillary, and mediastinal regions, until the age of 27. Three months later the last menstrual period occurred, but the diagnosis of pregnancy was delayed for eight months. During the first months of pregnancy the treatment consisted of the following: Chlorambucil, 380 mg in the first four weeks of gestation, and x rays, 2900 R to the enlarged spleen in the third to sixth month of pregnancy, 2500 R to the left axilla, and 5400 R to the left paravertebral region. The patient was delivered one month after term. The child developed progressive renal disease, characterized by early proteinuria, hyposthenuria, and glomerulotubular insufficiency, resulting in secondary hyperparathyroidism and uremic death at the age of eight yr. Autopsy findings revealed hyalinization of glomerular tufts, tubular atrophy, and marked interstitial fibrosis, compatible with the picture of radiation nephritis. Additional signs of radiation damage in the child included several somatic and psychomotor retardation, spastic tetraplegia, microcephaly, microphthalmia, nystagmus, skeletal hypoplasia, partial epilation, patchy pigmentations of the skin, ovarian fibrosis, and adrenal hyperplasia. (BBB)

26947 EFFECTS OF IONIZING RADIATION ON HeLa CELLS. V. EFFECTS OF GAMMA RADIATION ON INCORPORATION OF TRITIATED THYMIDINE. Herbin, Y.; Cappelaere, P.; Driessens, J. (Institut de Recherches sur le Cancer, Lille). Compt. Rend. Soc. Biol., 162: 1506-9(1968). (In French).

After γ irradiation of HeLa cells, the percentage of nuclei labeled with ^{3}H-thymidine for the whole cellular population is almost always inferior to that of non-irradiated labeled nuclei. The difference is not strictly proportional to the absorbed radiation dose, but is accentuated with increasing delays in mitosis manifested during 90 minutes after irradiation. The mean delay necessary for labeling of 50% of the metaphases is always long, even for cultures that have recovered a numerically normal mitotic activity. (tr-auth)

26948 FERTILITY RETAINED AFTER IRRADIATION FOR RECTAL CANCER. Krauss, A.; Buerger, G. (Univ., Leipzig). Geburtsh. Frauenheilk., 27: 1023-4(Oct. 1967). (In German).

The case of a 33-yr-old patient who gave birth to a healthy infant without malformations 10 yr after x-ray therapy with a dose of 6000 R for rectal carcinoma is reported. On the basis of 10 similar cases previously reported it is concluded that doses of irradiation greater than 280 R/hemipelvis are necessary in women younger than 45 yr old to terminate generative ovarian function. Because considerable scarification usually appears after localized Ra irradiation, caesarian section was recommended in 40% of these cases studied. Younger women with ovarian carcinoma who desire offspring should only be irradiated locally with 40 mg of Ra intracervically and 80 mg at the neck of the uterus. (BBB)

26949 EVISCERATION OF BOWEL THROUGH THE VAGINA FOLLOWING IRRADIATION FOR CERVICAL CARCINOMA: REPORT OF FIRST KNOWN CASE. Habeck, Edgar A.; Peters, Leo M. (Deaconess Hospital, Milwaukee). Wis. Med. J., 67: 374-5(Aug. 1968).

An unusual case of postirradiation small bowel evisceration through the vagina is presented. Factors of delayed progressive irradiation ischemic disintegration and destruction of the uterus and vaginal vault plus straining at stool possibly developing this complication are presented. For an infiltrating squamous cell carcinoma of the cervix, grade II, irradiation was given, employing the Ernst applicator with 65.5 mg of filtered Ra applied to the cervix, uterine cavity, and vaginal vault for a dose of 3078.5 mg-hr. Sixteen days after the first application, again employing the Ernst applicator, 50.5 mg of filtered Ra was applied to the cervix, uterine cavity, and vaginal vault for a dosage of 1818.0 mg-hr. Beginning 12 days later external ^{60}Co teletherapy was administered over a period of 32 days. Fifteen × 15 cm fields were irradiated anteriorly and posteriorly with a 4-cm strip blocked out in the midline. The dose delivered to the cervix was 12,425 R; point A, 7300 R; point B, 6,257 R. Examination 6 weeks later showed no skin reaction, and no diarrhea followed. The patient was regarded as in excellent postirradiation condition until bowel evisceration occurred 6 months later. No previous report of a similar complication following irradiation therapy for squamous cell carcinoma of the cervix could be found. The correction of the defect by vaginal surgery was successful. (BBB)

26950 COMPLICATIONS FROM PREOPERATIVE IRRADIATION THERAPY FOR LUNG CANCER. **Tildon, Timothy T.; Hughes, Richard K. (Wadsworth Hospital, Los Angeles). Ann. Thorac. Surg., 3: 307-66(Apr. 1967).**

Radiation-related injuries in 28 patients irradiated before surgical removal of lung cancers are reported. A 6-MeV linear accelerator was used to deliver an average of 4587 rad to 26 tumors and 4495 rad to the mid-mediastinum through anterior and posterior fields, which averaged 14 by 16 cm. Those with scalene nodes which contained metastases received an additional average of 5414 rad to both supraclavicular regions. About 150 rad tumor doses were given each day. Following combined treatment, four postoperative deaths occurred: one from bronchopleural fistula, one from pneumonia and empyema, one from acute radiation pneumonitis in the residual lung, and one from bilateral pneumonia. An additional postoperative death caused by pneumonia followed preoperative irradiation and exploratory thoracotomy. Four out of six patients developed evidence of irradiation fibrosis in ipsilateral residual lobes. Eight of 28 irradiated and resected patients developed postoperative pneumonia. At operation, hilar vessels were often shortened and fragile. Tumor margins were occasionally difficult to define. The average delay before operation for the irradiated patients was 77 days. The complication rate and mortality following preoperative irradiation were considered high in comparison to that of the controls. (BBB)

26951 THE CONSTANCY OF THE TYPES OF α_1-ACID GLYCOPROTEIN VARIANTS IN PATIENTS WITH UTERECTOMY AND IRRADIATION. Yoshizaki, H.; Hunziker, Kaethi; Schmid, K. (Boston Univ. Medical Center). Clin. Chim. Acta, 23: 147-51(Jan. 1969).

α_1-Acid glycoprotein (orosomucoid) was isolated in homogeneous state from blood of patients with cancer of the uterus taken before and after complete uterectomy and subsequent irradiation. The blood concentration of this glycoprotein was generally found to be increased above the normal level and was, in each case, further augmented following surgical trauma and irradiation. Yet in all cases studied, α_1-acid glycoprotein revealed properties (chemical composition of the carbohydrate moiety, electrostatic net charge, and immunochemical determinants) that were identical with those of normal α_1-acid glycoprotein. The type of the α_1-acid glycoprotein variants was determined by starch gel electrophoresis at pH 5.0 on the desialized glycoprotein. Constancy of the type of these variants was observed in each patient in spite of the considerable increase and variation in blood level of this glycoprotein. These observations were consistent with the concept of genetically controlled transmission of the α_1-acid glycoprotein variants. (BBB)

26952 PATIENT TOLERANCE TO EXTENDED IRRADIATION IN HODGKIN'S DISEASE. **Johnson, Ralph E.; Kagan, A. Robert; Hafermann, Mark D.; Keyes, John W. Jr. (National Cancer Inst., Bethesda, Md.). Ann. Intern. Med., 70: 1-6(Jan. 1969).**

Adverse effects of radiotherapy were followed in 114 patients treated for Hodgkin's disease. Extended irradiation included the cervical, supra- and infraclavicular, axillary, mediastinal, paraaortic, iliac, and inguinofemoral lymph nodes and the spleen. Radiotherapy was administered with either a ^{60}Co teletherapy unit or a 2-MeV Van de Graaff accelerator. The tumor doses were 3500 to 4000 R. Substantial depression of all blood cell types was observed by the end of radiotherapy with recovery during the ensuing 8 months. This posttreatment recovery was excellent for hemoglobin and platelet counts. Within five months after extended irradiation, the response of the peripheral blood neutrophil count to antigen stimulation had returned to near pretherapy levels. The posttreatment recovery of the absolute lymphocyte count was impressive after the intensive irradiation of multiple lymph node chains. Aside from the five to 10% incidence of herpes zoster, infectious complications did not result despite the significant leukopenia that quite consistently occurred. Neither were hemorrhagic problems encountered despite the low platelet counts. Most patients lost weight during radiotherapy, particularly with the development of pharyngitis and esophagitis during cervical and mediastinal irradiation. Most complications were not related to extended lymph node irradiation per se but to the local irradiation of large volumes with high doses. One patient developed an esophageal stricture that required dilatation. Acute gastroenteritis occurred as well as several instances of gastric ulceration. The most significant complication was radiation carditis; six patients developed symptomatic pericardial effusions. (BBB)

26953 VERRUCOUS SQUAMOUS CELL CARCINOMA OF THE ORAL CAVITY. Fonts, Ernesto A. (Univ. of Miami, Fla.); Greenlaw, Robert H.; Rush, Benjamin F.; Rovin, Sheldon. Cancer, 23: 152-60(Jan. 1969).

Verrucous-type oral tumors are reviewed. This variety of epidermoid carcinoma of the oral cavity presents a warty growth in patients who have a history of chewing tobacco and poor oral hygiene. They are slow-growing, locally invasive, and do not metastasize to lymph nodes in our experience. In five of these patients, the microscopic pattern was that of a well-differentiated squamous cell carcinoma. The others presented the classical histologic pattern of verrucous carcinoma. No difference was found in the behavior of these two groups. Three cases developed anaplastic transformation after γ irradiation and surgery. A change in the clinical behavior of the tumor was observed in these patients and all three died. There is some possibility that ionizing radiations could be the trigger mechanism in this transformation. The authors feel that surgery is the treatment of choice in early or easily resectable lesions. It would appear unnecessary to perform neck dissection in these patients. Radiation therapy should be used in advanced verrucal-type lesions in which surgical resection is difficult or not feasible. These patients require frequent and careful observation. (auth)

26954 EFFECT OF X RAYS AND HYPOXIA ON THE FETUS. **Jacobson, Ivan V. (Roosevelt Hospital, New York). Postgrad. Med., 44: 152-5(Oct. 1968).**

Effects of ionizing radiation on the human fetus are briefly reviewed and the case is described of a woman about one month pregnant hospitalized with a pulsating abdominal mass. During the diagnostic work-up, she received 15 to 25 rad over the uterus. When the mass, an aortic aneurysm, was resected, the aortic blood flow was interrupted for 90 min. She later gave birth to a normal term infant. There is no agreement as to what constitutes the lowest teratogenic dose of ionizing radiation in human beings. Radiation injury is doubtless most likely to occur in the period of tissue differentiation and fetal organogenesis, which is the period from day 14 to 42 post-conception. The radiation exposure in an x-ray examination of the chest (0.2 to 0.4 rad) has not been proved to be teratogenic. However, the abdomen should be protected by a lead apron. Obstetric radiographic procedures are usually carried out during the third trimester of pregnancy or when the patient is in labor (x-ray pelvimetry, placentography, flat plates of the abdomen). The usual technic delivers 0.4 to 2 rad to the fetus. If there is an obstetric indication for these procedures, they should be done. Abdominal x-ray procedures should not be done in the first trimester of gestation, as occurred in the case reported here. (BBB)

Radiation Effects on Plants

Refer also to abstracts 26686, 26720, 26722, 26730, 26731, 26735, 26736, 26738, 26739, 26741, 26744, 26745, 26747, 26752–26764, 26852, 26971, and 28659.

26955 POLLEN ANALYSIS OF LINUM USTATISSIMUM, L., THE RAJA AND CONCURRENT VARIETIES, FOLLOWING γ-RAY AND EMS TREATMENTS. Marki, A.; Bianu-Morea, M. Stud. Cercet. Biol., Ser. Bot., 20: 159-63(1968). (In Rumanian).

The results showed that the sterility increase was directly proportional to radiation and EMS concentration doses, being more conspicuous in the former case. Pollen sterility was correlated with the mature capsule sterility. High radiation doses resulted in flowers with very few pollen granules (25 to 50 fertile pollen + 50 to 100 sterile pollen). Even a lasting EMS treatment or a concentrated EMS solution are not likely to induce this phenomenon. Pollen sterility in the first generation was not indicative of the sterility rate in subsequent generations. (auth) (Rom. Sci. Abstr.)

26956 RADIOSENSITIVITY IN OKRA (ABELMOSCHUS ESCULENTUS). Patil, J. A. (College of Agriculture, Poona). Parbhani Agr. Coll. Mag., 8: 27-30(1966-67).

Dry dormant seeds of okra (Abelmoschus esculentus) were x-irradiated with total doses varying from 5,000 to 50,000 R. Radiosensitivity was examined on the basis of the percentages of seed germination and the survival rates of seedlings. Germination percentages varied, but the highest dose had no noticeable effect on germination. The percentages of survival seedlings were reduced at 40,000 and 50,000 R, 10 weeks after sowing. The irradiation effects were noticed in the development of seedlings and their growth rates. The seedlings were dwarf and the number of leaves produced on them was reduced. A wide range of response to x-irradiation was noticed including dwarfing, asymmetrical development, distorted veination in leaves, and an alternation of phyllotaxis. Okra (*A. esculentus*) appeared to be highly tolerant or less sensitive to *x irradiation* which might be the result of its polyploid nature. (auth)

26957 THE OXYGEN REQUIREMENT FOR RECOVERY IN SPLIT-DOSE EXPERIMENTS WITH OEDOGONIUM. Howard, Alma (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Int. J. Radiat. Biol., 14: 341-50(1968).

Split-dose experiments with vegetative stationary-phase cells of *Oedogonium cardiacum*, tested for loss of clonogenic ability, *showed that part of the* x-ray damage was repaired in a two-hr interval. The ability of the cells to repair was independent of the presence of oxygen during irradiation. When less than 0.01 μM/l. oxygen was present in the water surrounding the cells during the recovery interval, little or no recovery occurred. When 0.12 μM/l. oxygen was present, recovery was as complete as in air-saturated water. These results, and others quoted in the literature, support the hypothesis that recovery is a metabolic process that requires an energy source in the cell. (auth)

26958 EFFECT OF CHRONIC GAMMA RAYS ON MICROSPOROGENESIS AND POLLEN DEVELOPMENT IN CHENOPODIUM ALBUM LINN. Chaughan, Y. S. (B. R. Coll., Agra, India). Beitr. Biol. Pflanz., 45: 135-41(Dec. 23, 1968).

The plants were exposed to ^{60}Co γ radiation at dose rates of 75, 230, 425, or 685 R/day (22 hr/day) for 5 months. Endothecium in the anthers of unirradiated plants and in plants growing at 75 R/day developed fibrous thickenings, but in plants growing at the 230 R/day dose rate no fibrous thickenings in endothecial cells could be observed. In anthers of plants grown at the dose rate of 685 R/day a few tapetal cells had three nuclei. The tapetal cells remained organized until microspore formation, but by the time microspores separated they started losing contacts and were completely disorganized in the anthers of unirradiated and in plants growing at the dose rate of 75 R/day. Contrary to this, tapetal cells persisted for a longer period in the anthers of plants grown at the dose rate of 230 R/day. In the anthers of plants growing at 685 R/day the microspore mother cells became fused, while in a few other cases the microspore mother cells remained intact and developed thick walls. In such cases the anther ultimately degenerated. At 425 R/day, although pollen developed, it was completely sterile. The diameter of pollen grains at the dose rate of 75 and 230 R/day ranged between 20 to 40 and 25 to 50 μ, respectively, compared to 14 to 40 in controls. Clumping of pollen was observed at 425, 230, and 75 R/day. (BBB)

26959 LIBERATION OF A TUMORIGENIC PRINCIPLE IN TOBACCO CROWN GALL TISSUES BY X IRRADIATION. Aaron-Da Cunha, Maria Ivone (Laboratoire de Biologie Cellulaire I, Paris). Compt. Rend., Ser. D, 268: 318-21(Jan. 13, 1969). (In French).

If tobacco crown gall tissues are exposed to an x ray dose of 5000 to 6000 rads, a tumorigenic principle is released capable of inducing tumor transformations in healthy cells. (tr-auth)

26960 STUDY OF THE CHEMICAL NATURE AND DYNAMICS OF THE FORMATION OF LIPID RADIOTOXINS IN TISSUES OF HIGHER PLANTS. Kudryashov, Yu. B.; Sharkovskii, P. A.; Ishmukhamedova, M. S. (Moscow State Univ.). Biol. Nauki, No. 12, 64-8(1967). (In Russian).

Investigations were made on the possibility of the formation of lipid radiotoxins in irradiated plants; the chemical nature of the radiotoxins detected, the dependency between their formation and the radiosensitivity of the plants, the degree of development of radiation injury and the size of the dose, and also the linear energy loss of the ionizing radiation. Flax and hemp seeds were irradiated with γ rays (12 rads per second) and fission neutrons (6.0 kilorads per hour). For flax the doses were 70.0 kilorads with γ rays and 8.0 kilorads for fission neutrons; for hemp the doses were 15 and 2.5 kilorads, respectively. The relative biological effectiveness of these plants was determined according to the index of stalk growth. The relative biological effectiveness was nine for flax and six for hemp. The method of acid erythrograms was used to check the toxicity of the free fat extracted from the plants. Maximum toxicity was observed in preparations from seven-day sprouts of flax and hemp irradiated with γ radiation and fission neutrons; by the fourteenth day toxicity reached the level of the control. Accumulation of lipid radiotoxins was thus observed in the plants, and even with equivalent radiation doses the toxicity of lipid radiotoxins was higher in hemp than in flax. The hemolytic test was used to check the toxicity of the fraction of free fat. The toxicity of lipid radiotoxins was associated with the fraction of free acids. The composition of free fatty acids in the experimental and control samples taken by extracting lipids from flax and hemp at various intervals of growth was the same, namely, palmitic, stearic, oleic, linoleic, and linolenic acids. The content of the individual fatty acids in preparations of lipid radiotoxins changed insignificantly and could not result in their toxicity. At all intervals after irradiation the preparations contained 60 to 80% unsaturated fatty acids, a rich substrate for oxidation. The method of polarography in combination with the erythrogram method was used to analyze the oxidized products of higher unsaturated fatty acids on which toxicity depends. It was established that the biological activity of lipid radiotoxins was associated with the magnitude of the half-wave potential ($E_{1/2} = -1.25$ V) of lipid peroxides and epoxides. These data indicated that in their chemical nature the lipid radiotoxins of higher plants did not differ from the lipid radiotoxins of animals. (JPRS)

Radiation Effects on Microorganisms

Refer also to abstracts 26691, 26696, 26707, 26723, 26724, 26726–26729, 26732, 26733, 26749, and 26751.

26961 SUSCEPTIBILITY OF SCRAPIE AGENT TO IONISING RADIATION. Field, E. J.; Farmer, F.; Caspary, E. A.; Joyce, G. (Medical Research Council, Newcastle-upon-Tyne, Eng.). Nature (London), 222: 90-1(Apr. 5, 1969).

The resistance of the infective agent of scrapie to ionizing radiation has, together with its remarkable stability in a variety of physical and chemical conditions, given rise to a number of different ideas as to its nature and mode of action, including the conclusion that it does not depend on a nucleic acid for its ability to replicate. Studies are described using brains of sheep which had undergone intracerebral inoculation of mouse-adapted scrapie. Samples of oxygen-saturated brain tissue were ^{60}Co γ irradiated at a dose rate of 43,000 R/min to total doses ranging from 5 to 25 MR. Biological activity was then assayed by injection of suspensions of the material intracerebrally into mice and observing the animals for eight to 12 months, followed by histological examination. The relation between residual scrapie activity and total dose is shown graphically. Interpretation of the results on the basis of conventional target theory leads to the conclusion that the agent is small, with a molecular weight of $\sim 1.5 \times 10^5$, which is exceptionally small for a conventional virus. For a nucleic acid this would appear to entail an improbably small nucleotide code, although adequate for large peptides or small proteins. The rejection of nucleic acids solely on the basis of the length of possible message must, however, be treated with caution; small circular DNA (0.8×10^6 molecular weight) has been demonstrated in *M. lysodeikticus*. Furthermore, a number of factors may invalidate classical target theory in this case. If the irradiation technique provides a true measure of stability and size of a biological agent, the choice of structure and nature of the scrapie agent is between a rather primitive small virus, retaining full informational sequence in a short polynucleotide chain, and a non-nucleic replicating material probably inducing its own replication by conformational changes in the cell membrane. (UK)

26962 MUTANT OF ESCHERICHIA COLI K12 EXHIBITING VARYING ULTRAVIOLET SENSITIVITIES DEPENDING ON THE TEMPERATURE OF INCUBATION AFTER IRRADIATION. Suzuki, Kenshi; Saito, Etsuko; Morimyo, Mitsuoki (National Inst. of Radiological Sciences, Chiba City, Japan). Photochem. Photobiol., 9: 259-72(Mar. 1969).

A mutant, URT-43, was isolated from *Escherichia coli* C600 dar$^+$. The mutant has a characteristic feature in that its sensitivity to ultraviolet (uv) light is greatly influenced by the temperature at which irradiated bacteria are incubated. On the basis of dose-reduction factor, URT-43 is approximately ten times more sensitive at 42° than at 30°C, even though unirradiated bacteria are not thermo-sensitive. The mutant could not repair uv-irradiated bacteriophage λ_{vir} in the dark either at 30° or at 42°C, indicating that it is defective in host-cell reactivation. In contrast, the same bacteriophage was reactivated in preirradiated URT-43 if the host-bacteriophage complex was plated at 30° but there was no reactivation at 42°C. Therefore uv-reactivation was positive at 30° but negative at 42°C. The induction of prophage by URT-43(λ_h) was achieved by much lower doses of uv light than that required for the induction of lysogenic wild type bacteria. Experiments were performed in which irradiated URT-43 was first incubated for various periods in liquid media and plated both at 30° and 42°C. It was found that irradiated bacteria came to be resistant to subsequent plating at 42° only when they were preincubated in the liquid medium containing necessary amino acids and at 30°C. Since this phenomenon was completely inhibited by chloramphenicol, the process seemed to require *de novo* protein synthesis. An hypothesis was proposed that there are at least two independent dark-repair mechanisms in E. coli; one is responsible for host-cell reactivation and the other is responsible for uv-reactivation. (auth)

26963 SURVIVAL OF MICRO-ORGANISMS IN SPACE. COMPARISON OF SURVIVAL DATA OBTAINED IN FIFTEEN BALLOON-, ROCKET-, AND SATELLITE-BORNE EXPOSURE EXPERIMENTS WITH INCIDENT SOLAR PHOTONS. Lorenz, Peter R. (New York State Dept. of Health, Albany); Orlob, Gert B.; Hemenway, Curtis L. Space Life Sci., 1: 491-500 (Mar. 1969).

Survival of coliphage T_1, tobacco mosaic virus (TMV) and spores of Penicillium roqueforti Thom after direct exposure to space on board six balloons, six sounding rockets and three satellites is related to the numbers of solar UV photons incident during exposure. The survival followed exponential curves leading to complete inactivation. Solar ultraviolet radiation of wavelengths 2000 Å to 3000 Å appears to be the main cause of inactivation of broth suspended phage and, probably, TMV. T_1 phage and Penicillium spores prepared in saline were also affected by radiation shorter than 2000 Å, while TMV seems to be resistant to radiation of these wavelengths. The biological effectiveness of the solar spectrum in the area between 3000 Å to 50,000 Å was not significant. Sterilization of interplanetary spacecraft appears necessary since microorganisms can easily be shielded against lethal radiation. (auth)

26964 SUSCEPTIBILITY OF MILD THERMAL AND OF IONIZING RADIATION DAMAGE TO THE SAME RECOVERY MECHANISMS IN ESCHERICHIA COLI. Bridges, B. A.; Ashwood-Smith, M. J.; Munson, R. J. (Medical Research Council, Harwell, Eng.). Biochem. Biophys. Res. Commun., 35: 193-6(Apr. 29, 1969).

A correlation exists in Escherichia coli between sensitivity to ionizing radiation and to thermal stress at 52°C. It is suggested that systems involved in recovery from damage inflicted by ionizing radiation are those that in a natural environment repair or bypass mild thermal damage, for example the breakage of single strands of the DNA duplex. (auth)

26965 DEOXYRIBONUCLEATE BINDING AND TRANSFORMATION IN MYCOPLASMA LAIDLAWII. Folsome, C. E. (Univ. of Hawaii, Honolulu). J. Gen. Microbiol., 50: 43-53(Jan. 1968).

Experiments on DNA bindings, transformation, and uv radiation inactivation in M. laidlawii are reported. Ultraviolet inactivation studies were done with both M. laidlawii and Escherichia coli under similar standard conditions using a germicidal low-pressure mercury lamp. Under the conditions used, a 21-sec uv dose corresponded to one lethal hit for E. coli $F^-(\lambda)^s$ exponential phase cells. The uv inactivation studies showed that no caffeine-inhibitable uv dark-repair mechanism was present. Photoreactivation (PR) was demonstrable; the PR cross-sector was 0.39. M. laidlawii was capable of binding in deoxyribonuclease-resistant form high molecular weight double- or single-stranded homologous or heterologous DNA in amounts of 0.1 to 1.0×10^{-15} g/organism, in a temperature-dependent mode. The maximum amounts of bound DNA ranged from 25 to 125 molecules of 5×10^6 d. Transformation of streptomycin-sensitive recipients to streptomycin resistance under conditions of maximum DNA uptake was relatively rare, being about 2 to 4-fold higher than spontaneous mutation. From these results it was inferred that M. laidlawii is unable to be genetically transformed because of the absence of one or more steps that occur between irreversible DNA uptake and genetic integration. A model system which incorporates the above findings and suggests that donor DNA functions transiently in recipients is presented. (BBB)

26966 LETHALITY AND MUTATIONS PRODUCED BY TRITIUM DECAY IN BACTERIOPHAGES. Funk, Frederick Diven. University Park, Pa., Pennsylvania State Univ., 1967. 81p.

Thesis.

The values of the killing efficiency from decays of ^{3}H-thymidine or ^{3}H-6-hydroxymethylcytosine in T4 bacteriophage DNA, 0.124, and decays of five tritiated amino acids in T4 protein, 0.046, were determined. The ratio of the killing efficiencies obtained from DNA precursor to protein precursor, 2.7, was compared to a theoretical ratio, 2.3, which was calculated assuming that inactivation occurs solely by beta particle ionizations in the phage DNA. From this agreement it was concluded that no significant molecular rearrangement of the parent molecule important in the inactivation of T4 occurred from decays of these DNA precursors, and that the primary means of inactivation was by beta particle ionizations in the phage DNA. The absolute D_{37} dose delivered to the phage DNA volume from decays of these DNA precursors to be 83.5 Krads was also calculated. This value was in the range expected if all inactivation occurs by beta particle ionizations in the volume occupied by the DNA. The rate of inactivation and mutation production from decays of ^{3}H-5-cytosine, ^{3}H-6-uracil, and ^{3}H-thymidine were determined for two characterized mutants of S-13 which revert by C—T and T—C transitions. Decays of ^{3}H-5-cytosine were found to cause C—T transitions with a probability of 0.45 to 1.0 per decay. No measurable additional lethal effect of these C—T transitions could be detected. The average value of the killing efficiency for all three precursors was 0.50. The inactivation from three tritiated precursors and the mutation production from decays of ^{3}H-6-uracil and ^{3}H-thymidine were in all cases consistent with that which would be expected from the primary ionizations caused by the tritium beta particle. (Disser. Abstr.)

26967 SOME EFFECTS OF ACCELERATED CHARGED PARTICLES ON BACTERIAL SPORES. Powers, E. L.; Lyman, J. T.; Tobias, C. A. (Univ. of Texas, Austin. Univ. of California, Berkeley). Contract AT(40-1)-3408. Int. J. Radiat. Biol., 14: 313-30(1968).

Dry spores of Bacillus megaterium were irradiated with stripped atoms accelerated in the heavy ion linear accelerator. Nine different ions were used, each at 8.3 MeV/nucleon, with specific energy losses (LET) varying from 5 keV/μ (total) for the ionized deuteron up to 500 keV/μ for the Ne^{10+} ion. Survival curves were constructed for each ion in three experimental conditions allowing distinction among three classes of damage; class I, the completely oxygen-independent damage; class II, that seen only when oxygen was present during irradiation; and class III, that produced by interactions between oxygen and free radicals. Class I increased with increasing LET up to 190 keV/μ while classes II and III were constant in this range. Beyond this, II and III decreased to zero approximately at 500 keV/μ, with I falling slightly. Cross-sectional values corresponded with actual geometric dimensions of the spore: a high LET particle was lethal in any part of the protoplast; lower LET particles yielded cross-sectional values that were smaller than morphologically distinct parts of the spore. A numerical analysis indicated two limiting cross-sections, one being possibly a single event process important at low LET, and the other a cooperative process that was the chief effect at high LET. (auth)

26968 FACTORS MODIFYING RADIATION-INDUCED DAMAGE IN ESCHERICHIA COLI. Iyer, P. Seshadrinatha. Lawrence, Kan., Univ. of Kansas, 1968. 137p.

Thesis.

A study was made on the mechanism by which Escherichia coli B/r cells grown in nutrient broth containing 0.2% glucose (glucose-nutrient broth) acquired an enhanced resistance to γ rays (glucose-induced resistance). This was done by studying the effects of various modifying factors such as pH, post-irradiation incubation temperatures and chemical inhibitors on the γ radiosensitivity of B/r cells grown to stationary phase in nutrient broth or in glucose-nutrient broth. The effect of the modifying factors on the γ radiosensitivity of E. coli B and B_{s-1} cells which show negligible glucose-induced resistance was also investigated. A brief summary of the results was given: It was verified that B/r cells exhibited a higher survival at a post-irradiation incubation temperature of 18°C compared with that at 37°C (low temperature reactivation) but B and B_{s-1} exhibited negligible low temperature reactivation. Post-irradiation incubation of cells containing caffeine or acriflavin increased the sensitivity of cells to γ rays. The shoulder in the survival-curves of B/r cells grown in glucose-nutrient broth decreased with increasing concentration of either drug and finally disappeared. The ability of either drug to produce γ radiosensitization was less pronounced in the case of B_{s-1} cells. Caffeine was most effective in increasing the sensitivity of cells to γ rays during the first few hours after irradiation. It is shown that B/r cells irradiated with ultraviolet light exhibit drug-induced sensitization and glucose-induced resistance but negligible low temperature reactivation. A model which qualitatively explains these results was proposed. The mean features of this model were as follows: Repair enzymes are inducible. Some of the steps involved in the repair of damage induced by γ rays and ultraviolet light are identical. Caffeine and acriflavin affect either some or all enzymes which take part in the repair of both the ultraviolet light and γ radioinduced lesions or the lesions themselves in such a manner as to make them irrepairable. The enzymes responsible for the repair of γ radioinduced lesions appear to be more effective at a post-irradiation incubation temperature of 18°C than that of 37°C. Furthermore, it is assumed that the ratio of the activities of some or all of the other enzymes responsible for the repair of ultraviolet light-induced lesions to that of the general metabolic activities leading to cell division is not affected by changing the incubation temperature from 37°C to 18°C. (auth)

26969 SURVIVAL OF TOBACCO MOSAIC VIRUS IN SPACE. Orlob, Gert B.; Lorenz, Peter R. (Univ. of Toronto). Phytopathology, 58: 955-6(July 1968).

Effect of solar uv was studied in rocket experiments using tobacco mosaic virus (TMV), one of the most stable viruses known. Samples of TMV mounted on plastic-coated, sterile aluminum plates were exposed to space during 2 rocket flights. The first rocket was flown during the day, and samples were exposed to solar radiation for 204 sec at altitudes from 77 to 149 Km. Under these conditions, infectivity of exposed TMV was significantly reduced by a factor of 12, while infectivity of inverted samples shielded from direct solar radiation was unaffected. The infectivity of TMV on the second rocket, flown at night and exposed to space for 208 sec at altitudes from 79 to 142 Km, was not changed. Previous experiments also showed that solar radiation was the primary cause of reducing the biological activity of microorganisms in space. The 2000 to 3000 Å band of the solar spectrum is responsible for inactivation. (BBB)

26970 EFFECTS OF THE RUBY LASER ON BACTERIA. Deschaux, P.; Guillot, N.; Fontanges, R.; Peres, G. (Centre de Recherches du Service de Sante des Armees, Lyon. Faculte des Sciences, Lyon). Compt. Rend. Soc. Biol., 162: 1376-9(1968). (In French).

Escherichia coli were exposed to ruby lasers at the rate of 3 joules in 30 nsec and 20 joules in 1 msec. The bacteria were cultivated on agar or in liquid media. In the first case a phenomenon of all or nothing was observed if the ray was focused. In the second case a weak but constant mortality rate, which could be calculated, was noted. (tr-auth)

26971 VOSSTANOVLENIE I RADIOREZISTENTNOST' KLETKI. (Recovery and Radioresistance of the Cell). Zhestyanikov, V. D. Leningrad, Izdatel'stvo Nauka, 1968. 352p.

Recovery and radiosensitivity of cells following irradiation are reviewed. Chapter I consists of a detailed discussion of the radiosensitivity of *Escherichia coli* to γ rays and the effects of antibiotics, continuous cultivation, and temperature on this radiosensitivity. Chapter II deals with the role of the nuclear apparatus in the radiosensitivity of the cell. The roles of intracellular radioprotective substances (–SH binding) in the radiosensitivity of *E. coli* are discussed in Chapter III. Chapter IV is devoted to the role of recovery (repair and methods of repair of radiation damages) in the resistance of *E. coli* to x radiation. Molecular mechanisms of repair of uv radiation damage and their role in recovery of *E. coli* and T phages are considered in Chapter V. Chapter VI pertains to the specificity of reactiviation mechanisms in *E. coli*, yeasts, and spore-forming organisms to damage induced by uv and x rays. A discussion of conclusions with regard to the overall role of recovery in radioresistance of all biological systems concludes the book. (C.O.)

26972 INACTIVATION BY UV, X, AND γ RADIATIONS OF TWO PROPERTIES OF SV-40 VIRUS: INFECTIVITY AND ABILITY TO INDUCE EARLY NUCLEAR ANTIGEN. Coppey, J.; Wicker, R. (Institut Pasteur, Paris). Ann. Inst. Pasteur, 115: 478-85(Sept. 1968). (In French).

Radiosensitivity of infectivity and antigen induction properties was examined in SV-40 virus. Ultraviolet irradiation at 2537 Å gave a dose of 115 erg/mm^2 sec. Ionizing irradiation was also carried out with 37 kV x rays at 60 kR/min and by ^{60}Co γ rays at 10 kR/min. The virus was irradiated with uv radiations and x rays under conditions where the indirect effects were predominant, and with γ rays under conditions of a direct effect. The plaque-forming capacity of the irradiated virus was compared with its ability to induce the early nuclear antigen in monkey kidney cells. The plaque-forming capacity was about three times more sensitive than the induction of antigen to uv radiation and to the indirect effects of x rays. On the other hand, the 2 capacities were equally resistant to the direct effects of γ radiation. The most likely explanation of these observations seems to be that only $\frac{1}{3}$ of the infective genoma of SV-40 is necessary for the induction of the nuclear antigen. The γ rays may cause breaks in the DNA chains of SV-40 which are lethal as far as the 2 capacities studied are concerned. (BBB)

Radiosterilization and Radiopreservation

Refer also to abstracts 26417–26419, 26464, and 26465.

26973 (CONF-670649–21) USE OF ^{137}Cs GAMMA RADIATION IN VARIOUS TESTS ON FOOD PRESERVATION. Fernandez y Gonzalez, A. (Instituto Nacional de Investigaciones Agronomicas, Madrid (Spain)). May 1967. 21p. (In Spanish). Dep.

From Symposium on Applications of Radioisotopes, Madrid, Spain.

Some results obtained in the preservation of food with γ radiation are reported. Some positive results obtained in the inhibition of buds in stored potatoes and the zero effect that gibberellic acid appears to have, at concentrations of 5 to 500 ppM, on a possible recovery of the budding capacity in irradiated potatoes are given. The insecticide effect of γ radiation on three coleoptera that plague cereals, *Sitophilus granarius* L., *Trogoderma granarium* Everts, and *Tribolium castaneum* Hbst., is illustrated. The data obtained on the biological value of the protein of a mixture of wheat flour, irradiated at levels of 20 and 200 krad, indicate significant differences with respect to non-irradiated flour. The irradiation of Chili strawberries *Fragaria chiloensis* increases the period of commercial preservation. Doses of the order of 200 krad permit good preservation for 5 to 6 days at room temperature, which can be prolonged up to 18 to 20 days if the temperature does not exceed 4°C. The fungicide effect of γ radiation on spontaneous yeasts of grape and apple wines was studied. Some results were reported on the variation of the fermentative chronology as a function of the dose. (tr-auth)

26974 (CONF-670649–24) STERILIZATION OF CERATITIS CAPITATA WIED BY THE USE OF GAMMA RADIATIONS. Jimenez, Antonio; Arroyo, Manuel; Mellado, Luis; Caballero, Fernando (Instituto Nacional de Investigaciones Agronomicas, Madrid (Spain)). [1967]. 8p. (In Spanish). Dep.

From Symposium on Applications of Radioisotopes, Madrid, Spain.

The studies made on the sterilization of *Ceratitis capitata* Wied by the use of cesium-137 γ radiation are summarized. The studies showed that the most efficient time for irradiation is seven days after the formation of the pupa. The optimum dose is 8,000 rads. With this dose females are obtained that can not breed and males with sufficient capacity to breed with normal females, but whose eggs do not produce larvae. (tr-auth)

26975 (CONF-670649–37) PRESENT STATE, FUTURE POSSIBILITIES, AND POTENTIAL ECONOMIC IMPACT OF THE PRESERVATION OF FOODS BY IRRADIATION ON A COMMERCIAL SCALE. Ortin Sune, N. (Junta de Energia Nuclear, Madrid (Spain)). [1967]. 17p. (In Spanish). Dep.

From Symposium on Applications of Radioisotopes, Madrid, Spain.

The problem of food irradiation is not approached from the viewpoint of its principles since its historic development and fields of practical application have been amply treated in previous publications. An attempt is made to give a panoramic view of the present state, future possibilities, and potential economic impact of this method of food preservation. The sectors that can be affected by the commercialization of irradiated foods are discussed. These include food production, food processing, packing industry, manufacturers of irradiation sources and installations, storage and refrigeration installations, transport industry, and the chemical industry. (J.S.R.)

26976 (IA–1160) IRRADIATED CITRUS FRUITS AND THEIR EXTERNAL APPEARANCE DURING PROLONGED STORAGE. Kahan, R. S.; Padova, R. (Israel Atomic Energy Commission, Tel Aviv). July 1968. 24p. Dep.

The storage properties of citrus fruit were individually assessed for some 5000 fruit after irradiation and other treatments. The incidence of peel damage and the proportion of saleable fruit was determined. The peel damage was markedly reduced by artificial waxing as compared with fruit with only its natural wax. Preliminary organoleptic tests by a taste panel did not reveal marked radiation-induced differences. Waxing raised the radiation threshold dose. The wax and the method of waxing employed affected the extent of peel damage. Other variants, such as extending the post-harvest-irradiation delay, chemical dips, and substituting N_2 for O_2 in the atmosphere during irradiation, did not decrease the damage, and in some cases, increased it. A combination of dipping the fruit into water at 52°C and irradiation did not increase, and in some instances decreased, the damage to waxed fruit peel. (auth)

26977 EFFECT OF IONIZING RADIATION ON MEAT WITH CONSIDERATION OF THE SANITARY-VETERINARY APPRAISAL. Kossakowski, Stefan. Med. Wet. (Poland), 22: 709-14(Dec. 1966). (In Polish).

As a general rule, the effect of ionizing radiation on biological materials is considered injurious. When examining the problem of irradiated meat from the viewpoint of human health, the artificially induced radioactive materials must be taken into account. The radioactivity induced by neutron radiation is small; from the practical viewpoint, only the activity induced in sodium and phosphorus must be considered. The half-life of the induced radioisotopes is important; as most of the activity is due to short-lived isotopes, after a certain interval the meat must be suitable for human consumption. The radiometric measurements must be combined with sanitary and veterinary studies. The biochemical effects of radiation are more difficult to appraise because they are more complex. The nutritional value of the meat may be affected and toxic materials may be created. The biochemical problems involve also aftereffects, due to the radiolysis of water and the destruction of enzymes, proteins, etc. Irradiation due to conservation efforts and accidental exposure resulting from nuclear accidents present different problems. At the present time it is not absolutely certain whether irradiated meat is suitable for human consumption. (TTT)

26978 STATUS OF THE U. S. ARMY PROGRAM IN FOOD IRRADIATION. Josephson, Edward S.; Wierbicki, Eugen (Army Natick Labs., Mass.). Chem. Eng. Progr., 64: Symp. Ser. No. 83, 87-96(1968).

From American Inst. of Chemical Engineers Meeting, Atlantic City. See CONF-660903.

The scientific feasibility of the radiation sterilization process was demonstrated on a laboratory scale for several prepackaged meats, poultry, fin fish, and shell fish that were highly acceptable organoleptically. FDA and USDA have approved the Army's petition for irradiation sterilized canned bacon, and are reviewing a petition for ham. FDA has approved five flexible packaging materials as food contactants for the radiation sterilization process. Petitions are in preparation for additional irradiation sterilized foods and packaging materials. FDA has also approved irradiated white potatoes (sprout inhibition) and wheat flour (insect deinfestation). Based upon extensive feeding studies of 21 irradiated foods to laboratory animals, the Army Medical Service has concluded that foods irradiated up to absorbed doses of 5.6 megarads with a ^{60}Co source of γ irradiation or with electrons with energies up to 10 MeV are safe for consumption. The irradiation preservation of foods program is now ready for the next phase, the production of pilot plant quantities. In anticipation of FDA and USDA clearances, a commercial company has contracted with the U. S. Atomic Energy Commission to build and operate a pilot plant irradiation facility for producing irradiation sterilized foods. A milestone in the program occurred in 1966 with the first successful commercial production of an irradiation-sterilized food. The Defense Supply Agency procured from two commercial producers 30,000 pounds of canned shelf-stable bacon which was evaluated by Air Force and Army personnel and scored very well. Irradiated potatoes and wheat flour were successfully produced commercially in 1967. The future of the irradiation preservation of foods process depends upon receipt of clearances by FDA and USDA. We are confident that the clearances will be forthcoming so that the irradiation preservation of foods process will be established on a commercial scale within the next few years. (auth)

26979 WHOLESOMENESS TESTING OF IRRADIATED FOODS. Raica, N. Jr. (Fitzsimmons General Hospital, Denver). Chem. Eng. Progr., 64: Symp. Ser. No. 83, 66-70(1968).

From American Inst. of Chemical Engineers Meeting, Atlantic City. See CONF-660903.

Twenty-one foods such as meats, fish, fruits, and vegetables irradiated to 5.58 Mrads and fed to rats, dogs, mice, and monkeys for two yrs were found to be as wholesome as nonirradiated foods. These foods were fed as single components comprising 35% of the dietary solids, as two components comprising 70% of the dietary solids, or as five to nine components comprising 100% of the dietary solids. Over 15,000 mice, 10,000 rats, 300 dogs, and 37 monkeys were used in these studies. (auth)

26980 RADIOPASTEURIZATION OF PRODUCE. Maxie, E. C.; Sommer, N. F. (Univ. of California, Davis). Chem. Eng. Progr., 64: Symp. Ser. No. 83, 63-5(1968).

From American Inst. of Chemical Engineers Meeting, Atlantic City. See CONF-660903.

Among the facts derived from intensive studies on the radiopasteurization of produce are: there is no significant loss in nutritive value, vitamin content is stable at tolerable doses, there is no induced radioactivity, not unsafe for human consumption, refrigeration is still required, freedom from decay is not synonymous with quality in irradiated produce, and greatest benefit is reduction of losses during normal marketing period. It has also been determined that the more nearly a fruit approaches full ripeness, the less harm radiation does to it. The limiting factor in the irradiation of most fruits is an immediate and dramatic loss in texture at doses required to inhibit even modest infections with rot fungi. Those fruits that show the greatest promise for the application of irradiation are: strawberries, tomatoes, papayas, bananas, and a variety of produce including beans, prunes, persimmons, bramble berries, and potatoes. A major problem in the application of radiation on an industrial scale is the matter of Food and Drug clearance. (E.R.B.)

26981 PRODUCTION TEST IRRADIATION OF 30,000 POUNDS OF BACON. Manowitz, Benard (Brookhaven National Lab., Upton, N. Y.); Galanter, Leonard; Loeb, William A.; Milau, Julius S.; Rizzo, Francis X. Chem. Eng. Progr., 64: Symp. Ser. No. 83, 49-62(1968).

From American Inst. of Chemical Engineers Meeting, Atlantic City. See CONF-660903.

A total of 29,962 lb. of canned bacon was treated with γ radiation at the Brookhaven National Laboratory in conformance with the specifications of the U. S. Army Quartermaster Corps. The average minimum dose was measured as 5.077 megarad; the average maximum dose measured was 5.27 megarad. The radiation source consisted of a single 31 in. by 53 in. plaque containing 812,860 curies of ^{60}Co. Source shaping plus steel and aluminum absorbers were used to obtain a uniform dose field. The irradiation was completed in 136 hr. with an average source utilization efficiency of 11.7%. All bacon passed Department of Agriculture incubation tests. (auth)

26982 U. S. DEPARTMENT OF AGRICULTURE RESEARCH PROGRAM AND FACILITIES FOR THE USE OF GAMMA IRRADIATION IN THE CONTROL OF STORED-PRODUCTS INSECTS. Laudani, Hamilton; Tilton, E. W. (Stored-Product Insects Research and Development Lab., Savannah). Chem. Eng. Progr., 64: Symp. Ser. No. 83, 42-8(1968).

From American Inst. of Chemical Engineers Meeting, Atlantic City. See CONF-660903.

Results of small-scale tests on the use of ionizing energy for insect disinfestation of grain and grain products were sufficiently promising to warrant pilot-plant studies. Doses of 20,000- to 50,000 rad. γ irradiation appeared to stop successfully the development of most grain insects without affecting seriously the quality of at least certain grains and grain products. An irradiator having a ^{60}Co source of about 26,000 curies was constructed by the Atomic Energy Commission at the U. S. Department of Agriculture Stored-Product Insects Research and Development Laboratory, Savannah, Georgia. The irradiator is capable of treating 2,500 to 10,000 lb. of grain or about 2,000 lb. of packaged products/hr. This unit is being utilized to develop the most practical and economical use of γ radiation for insect disinfestation of grain and grain products. (auth)

26983 GAMMA IRRADIATION FOR VEGETABLE STORAGE: ONION BULBS. Patil, J. A. (College of Agriculture, Poona). Parbhani Agr. Coll. Mag., 7: 3-11(1965-66).

Ninomiya Globe onion bulbs were γ irradiated at pre-sprouting period with total dose varying from 5,000 to 6,000 R high and low dose rates. Irradiation prolonged the storage life externally and reduced shrinkage losses. Irradiation markedly inhibited the external and also reduced internal sprouting, but increased the amount of decay in storage. Irradiation with 10,000 R and above completely inhibited sprouting external as well as internal and rooting for practical purposes. Irradiation usually injured or killed the growing point which turned brown (dark) during storage. The area involved varied considerably from bulb to bulb and with levels of irradiation. The growth of the inner buds was found to be stopped by irradiation. There was no consistent effect of irradiation on the amount of decay either in storage or after planting. The stage of onions at the time of irradiation, the choice of variety, dose rate, and levels of irradiation and storage period of the irradiated bulbs appeared to have a great effect on the practical utility of γ irradiation in prolonging onion storage. (auth)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstracts 26478, 26481, 26485, and 27139.

26984 (BMwF-FBK-68-56) INVESTIGATION OF REACTOR FUEL MATERIALS AT HIGH TEMPERATURES. Lindner, R. (Technische Hochschule, Brunswick (West Germany). Institut fuer Kern- und Radiochemie. European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Dec. 1968. 14p. (In German). Dep.

Investigations of actinide diffusion were continued for base materials such as hyperstoichiometric uranium carbide ($UC_{1.1}$) and plutonium. The results obtained up to now show that the activation energy of diffusion in UC increases strongly with increasing carbon content. X-ray investigations of metallic Th-Pa alloys obtained by the Van Arkel process with Pa-contents ranging from 1 to 30% were executed. Complete solid solution behavior is observed at Pa-contents <10%. Pure protactinium monocarbide, PaC, was prepared for the first time and its lattice structure was determined. It is of the NaCl-type with $a_0 = 5.0608 \pm 0.0002$ Å. Running investigations of the pseudo-binary phase diagram UC/UO by high temperature x-ray diffractometry were continued. A new study was started concerning the development of a pyrochemical reprocessing procedure for irradiated thorium fuel using the salt transport process. (auth)

26985 INTERNATIONAL CONFERENCE ON CHARACTERIZATION OF MATERIALS HELD AT UNIVERSITY PARK, PENNSYLVANIA, NOVEMBER 16–18, 1966. Henisch, Heinz K.; Roy, Rustum (eds.). Materials Research Bulletin, Volume 2, 1967. New York, Pergamon Press, 1967. 650p. (CONF-661126).

A total of 66 papers were presented at the conference. A separate abstract was prepared for each of eleven papers. Seven papers were previously abstracted in NSA as 22: 4800, 22: 4801, 22: 4816, 22: 4818, 22: 4872, 22: 4892, and 22: 4905. Papers for which no abstracts were prepared are concerned with ferrites, mixed oxides, macroliquation, d electrons, crystal structure, single crystals, Se properties, Ga–Sb compounds, impurity doping of crystals, spectroscopy, electron paramagnetic resonance, crystal defects, intermetallic TiNi, lead iodide, crystal growth, cation coordination, lead aluminates, index of refraction, differential thermal analysis, arc melting, ionic solids, semiconductors, spinels, rare earths, chromium oxides, barium titanates, and preferred orientation. A list of new books is included. (J.R.D.)

For abstracts of individual papers see: 27009, 27153, 27154, 27173, and 27189–27195.

26986 OSNOVY METALLURGII. TOM PYATYI. MALYE, BLAGORODNYE I RADIOAKTIVNYE METALLY. TRANSURANOVYE ELEMENTY. (Fundamentals of Metallurgy. Volume 5. Small, Noble, and Radioactive Metals. Transuranic Elements). Greiver, N. S.; Sazhin, N. P.; Strigin, I. A.; Troitskii, A. V. (eds.). Moscow, Izdatel'stvo Metallurgiya, 1968. 632p.

Data are presented on the natural resources, technology and uses of minor, precious, radioactive and transuranium elements as well as silicon, chromium, manganese sulfur, phosphorus, and arsenic history. Chemical and physical properties, preparation, treatment, separation, and crystallization of uranium, radium, thorium, polonium, actinium, protactinium, francium, transuranium elements, gold, silver, and platinum are described. (R.V.J.)

26987 AN ORBITAL GRINDER–POLISHER FOR PREPARATION OF IRRADIATED METALLOGRAPHY SPECIMENS. Gruber, W. J.; Watts, E. C. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. Metallography, 1: 303-9(Jan. 1969).

A unique orbital grinder-polisher was developed, fabricated, and installed in hot cells for the preparation of irradiated specimens for optical metallography. The compact unit occupies approximately 0.2 cubic foot of cell space. It was specifically designed to provide the capabilities of commercially available vibratory polishers without their large space requirements. Units have been in operation about two years. The design of the grinder-polisher is described, operating experience is discussed, and illustrations of results are presented. (auth)

26988 VACUUM IN EXTRACTIVE METALLURGY. Winterhager, H.; Krueger, J. (Institut de Metallurgie et d'Electrometallurgie, Aix-la-Chapelle, France). Vide, No. 137, 288-318(Sept.-Oct. 1968). (In French and German).

A comprehensive review of recent developments in the thermodynamics and industrial applications of vacuum reduction processes for production of high-purity metals and alloys is presented. Data are given for reactions during the carbo-thermic reduction of Cr, Nb, Ta, and V from their oxides. The metallothermic reduction of metal halides by Mg or Na is discussed, as is the production of metallic Mg from dolomite by reduction with ferrosilicon, aluminum or calcium carbides, the metallo-thermic reduction of rare earth oxides, and vacuum distillation methods for preparation of Pb, Zn, Ca–Cu alloys SiCa–AlCa alloys and ferrochrome. Line drawings illustrate fundamental processes and equipment, and photographs show installations of large-scale industrial equipment. 93 references. (P.G.C.)

Corrosion and Erosion

Refer also to abstracts 27091, 27099, 27109, and 27409.

26989 (AERE-R-5903) POST-TRANSITION CORROSION OF ZIRCALOY-2, LOW-NICKEL ZIRCALOY-2 AND ZIRCALOY-4 BY STEAM AT 300°C AND 340°C: DEUTERIUM ABSORPTION AND THE INFLUENCE OF HEAT TREATMENT. Findlay, J. R.; Knights, C. F.; Perkins, R. (Atomic Energy Research Establishment, Harwell (England)). Nov. 1968. 19p. Dep. CFSTI. UK 3s. 0d.

The rates of corrosion and deuterium absorption of the alloys were compared at 300 and 340°C in D_2O steam at approximately 100 mg dm^{-2} weight gain. The post-transition region was reached by pre-oxidation in H_2O steam at 450°C followed by a prolonged exposure at the lower temperature until the rate of reaction became constant. On the basis of corrosion behavior the alloys can be divided into two groups. The alloys of group I, beta-quenched Zircaloy-2 and low-nickel Zircaloy-2, showed identical corrosion behavior and had a lower deuterium absorption rate but a higher oxidation rate than alloys of group II (alpha-annealed Zircaloy-2, low-nickel Zircaloy-2 and Zircaloy-4 and beta-quenched Zircaloy-4). The latter alloys showed similar corrosion behavior, with a few exceptions. The presence of beta-quenched Zircaloy-4 with the alpha-annealed alloys is a reflection of the fact that the corrosion behavior of Zircaloy-4 was insensitive to heat-treatment. (auth) (UK)

26990 (CEA-tr-A-1965) ELECTRON MICROSCOPE STUDIES OF THE PHENOMENON OF CORROSION CAUSED BY LIQUID SODIUM AT 600°C ON AUSTENITIC STAINLESS STEEL AND ALLOYS OF NICKEL. Gross, R.; Ulrich, H. Translated into French from Werkst. Korros., 18: 777-82(1967). 19p. (In French). Dep.

Corrosion of the surfaces of a metal cylinder was examined using an electron microscope. Observations showed that corrosion is an interaction of the processes of dissolution and precipitation. The sodium dissolved the metal from the surfaces, and the metal was precipitated into the grain boundaries and on the grain surfaces. Analysis of these precipitants showed that they had previously been part of the surrounding metal. (F.S.)

26991 (IITRI-578-P-29-35) RESEARCH ON ZIRCALOY BRAZE ALLOY DEVELOPMENT. (IIT Research Inst., Chicago, Ill.). Apr. 18, 1969. Contract AT(11-1)-578. 21p. (EURAEC-2101). Dep. CFSTI.

Work Performed Under United States–Euratom Joint Research and Development Program.

Brazed specimens of Zircaloy, which were exposed to hydrodynamic testing for a full 3000 hr period in the boron shimmed loop with lithium hydroxide for pH control, were evaluated on the basis of visual appearance, weight change, mechanical properties, and metallographic examinations. A new series of 170 brazed samples, representing 17 selected brazing alloys plus control specimens, were prepared, and exposure was initiated in the ammonia controlled loop. (auth)

26992 (N-69-10764) EVALUATION OF COATED MOLYBDENUM AND COLUMBIUM ALLOYS IN HIGH-TEMPERATURE SUPERSONIC AIRSTREAMS. Miller, Irvin M. (National Aeronautics and Space Administration, Langley Station, Va. Langley Research Center). Nov. 1968. 32p. (NASA-TN-D-4877). CFSTI.

The oxidation behavior of Durak B and Vought IX coated TZM, and Cr–Ti–Si, and Cr–$MoSi_2$ coated Nb-752 in supersonic air streams was investigated. Cyclic coating life and temperature data were obtained on 0.375-inch-diameter blunt-nose models at surface temperatures from 2600 to 3000°F and at air stagnation pressures behind the shock wave of 0.03, 0.10, and 5.5 atmospheres. The oxidation behavior of uncoated molybdenum- and niobium-alloy models of the same size and shape was also studied in the same test environments. Coating life of the TZM/Durak B, Nb-752/Cr–Ti–Si, and Nb-752/Cr–MoSi$_2$ systems was significantly lower at air stagnation pressures of 0.10 and 0.03 atmosphere than at 5.5 atmospheres. At these low-pressure conditions, the coating life of these three coating systems did not exceed 32 minutes. The uncoated niobium alloys oxidized catastrophically at air stagnation pressures of 0.10 and 0.03 atmosphere in less than 20 seconds at temperatures well below the melting points of the alloys. (auth) (STAR)

26993 (ORNL-TM-2021(Vol.1)) EFFECT OF ALLOYING ADDITIONS ON CORROSION BEHAVIOR OF NICKEL–MOLYBDENUM ALLOYS IN FUSED FLUORIDE MIXTURES. DeVan, Jackson Harvey (Oak Ridge National Lab., Tenn.). May 1969. Contract W-7405-eng-26. 45p. Dep. CFSTI.

Thesis. Submitted to Univ. of Tennessee, Knoxville.

Fused fluoride mixtures containing UF$_4$ have been developed as fuel solutions for high-temperature nuclear reactors. To develop container materials for such mixtures, the corrosion properties of nickel-molybdenum alloys with various solid-solution strengthening additions were investigated. These evaluations utilized thermal convection loops which circulated salt mixtures between a hot-zone temperature of 815°C and a cold-zone temperature of 650°C. The alloys selected for study contained 17 to 20% Mo and various percentages of Cr, Al, Ti, V, Fe, Nb, and W. Loops of individual alloys were exposed to the salt mixture NaF–LiF–KF–UF$_4$ (11.2-45.3-41.0-2.5 mole %) for periods of 500 and 1000 hr. Measurements of the concentrations of corrosion products in after-test salt samples indicated the corrosion susceptibility of alloying additions to increase in this order: Fe, Nb, V, Cr, W, Ti, and Al. However, metallographic examinations of loop surfaces showed relatively light attack for all alloys except those containing combined additions of aluminum and titanium or aluminum and chromium. A nickel-base alloy containing 17% Mo, 7% Cr, and 5% Fe, designated Hastelloy N, was found to afford the best combination of strength and corrosion resistance among the alloy compositions tested. (auth)

26994 THE CHEMICAL PARTITIONING OF ELEMENTS IN GAMMA PRIME SEPARATED FROM PRECIPITATION-HARDENED, HIGH-TEMPERATURE NICKEL-BASE ALLOYS. Kriege, Owen H.; Baris, J. M. (Pratt and Whitney Aircraft, Middletown, Conn.). ASM (Amer. Soc. Metals), Trans. Quart., 62: 195-200 (Mar. 1969).

Modifications of a method for quantitative separation of γ' from Udimet 700 by anodic dissolution of the sample matrix in a 1% solution of ammonium sulfate and citric acid were extended to other superalloys. A comprehensive study was made of the separation of γ' from 15 commercial, precipitation-hardened nickel-base alloys. Techniques are presented for the chemical analysis of the separated phases, and compositions of the γ and γ' in typical commercial heats of the 15 alloys were determined. In addition, formulas of the separated γ' were calculated, lattice parameters of the γ' were measured, and the partitioning of elements between γ and γ' was determined. (auth)

26995 INTERGRANULAR STRESS–CORROSION RESISTANCE OF AUSTENITIC STAINLESS STEELS IN WATER/OXYGEN ENVIRONMENTS: ACCELERATED TEST PROCEDURE. Wilde, B. E.; Weber, J. E. (General Electric Co., Pleasanton, Calif.). Brit. Corros. J., 4: 42-6(Jan. 1969).

Materials used in water-cooled nuclear reactors may fail due to intergranular stress-corrosion cracking (IGSC). Attempts to explain these failures by accelerated tests have not produced IGSC under realistic conditions; i.e., in high-purity water at elevated temperatures. Experiments were designed to distinguish between the influence of gross plastic deformation and heat-treatment on the IGSC behavior of a variety of austenitic stainless steels using 100-ppM dissolved oxygen as an accelerator at 289°C. The experimental variables studied included heat-treatment, carbon content, and alloy composition. Annealed Type-304 stainless steel when stressed in uni-axial tension did not show cracking even in high concentrations of hexavalent chromium ions. Sensitized Type-304 stainless steel (24 hr at 595°) developed intergranular fracture in 17 hr. The time-to-failure value in the sensitized condition was a function of the carbon content of the alloy. Data on carbon-containing alloys indicated that, below 0.03 wt % carbon, no stress-corrosion cracking occurs over a test period of 300 hr. Duplex alloys (austenite + ferrite) showed no tendency to stress-corrosion cracking even at high carbon levels and after heat-treatment at 595° for 24 hr. Thick welded sections of Type-304 stainless-steel plate behaved in a similar manner to fully sensitized Type-304 stainless steel and developed intergranular fracture in 42 hr. Welded Type-304L stainless steel was not affected in this way. (BBB)

26996 RADIOACTIVE EROSION MEASUREMENTS ON ROTARY LATHES MADE OF HIGH SPEED TOOL STEEL. Scheffler, Gert (Technische Hochschule, Karl-Marx-Stadt, Ger.). Wiss. Z. Tech. Hochsch. Karl-Marx-Stadt, 9: 123-9(1967). (In German).

A radioactive method is described for measuring wear in steel lathes. The method is based on detection of metal eroded from neutron-activated steel inserts. The most important factor for the sensitivity of the method is the specific activity of the steel insert sample, which is limited by its radiation hazard. The total activity of each sample is 1.25 Ci, but the effective γ radiation burden is 423 mCi. Unshielded, each metal insert produces a dose of 45 mR/hr at a distance of 1 m. The irradiation is reduced by $\sim$25% while the insert is carried in a container from the storage area, and it is attached to the lathe by a manipulator remotely across a Pb wall. The average irradiation dose amounts to 15 mr/day when the irradiated inserts are handled. This could be reduced if smaller size metal inserts were used. Results of the wear tests are illustrated and discussed. (BBB)

26997 METALS FOR NUCLEAR REACTOR CLADDING. Huet, J.-J. (CEN, Mol, Belgium). Rev. A.T.B. Met., 8: No. 1, 3-11(1968). (In French).

Development of fuel canning materials is reviewed from the standpoint of requirements of different types of nuclear power reactors. Information is included on Mg base alloys for CO$_2$ gas-cooled reactors, fabrication and properties of austenitic stainless steels or Zr alloy tubes for water-cooled reactors, fabrication methods and problems connected with SAP cladding for organic-cooled reactors, pyrolytic carbon coatings on spherical particles for high-temperature gas-cooled reactors, and high temperature irradiation induced brittleness in stainless steels and Ni alloys. Use of V-base alloys and dispersion containing steel are discussed. (P.G.C.)

26998 A COMPARISON OF FIELD AND LABORATORY CORROSION TESTS OF AISI TYPE 430 STAINLESS STEELS. Garrison, J. G.; Biefer, G. J. Technical Bulletin No. TB 91. Ottawa, Department of Energy, Mines, and Resources, [1969]. 19p.

Field tests and accelerated dip-and-dry laboratory tests were carried out to determine the effects of additions of U and Mo on the corrosion properties of AISI 430 stainless steel, used as automotive trim. A slight increase in corrosion resistance was obtained with an alloy containing 0.24% U, while no deleterious effect was experienced with an alloy containing 0.55% U. Increased corrosion resistance was observed with increased Mo for two alloys, one of which contained 1.02% and the other 2.03% Mo. Correlation of results between the accelerated dip-and-dry laboratory tests and the field tests was not entirely satisfactory. There, was, however, some area of agreement between these tests, and further use of the accelerated laboratory test appears warranted. (auth)(Canada)

26999 METHOD OF APPLYING OXIDATION PROTECTIVE COATINGS TO NIOBIUM. Yenawine, David L.; Hirakis, Emanuel C. (to United Aircraft Corp.). U. S. Patent 3,432,334. Mar. 11, 1969. Filed Dec. 2, 1963.

The method of protecting Nb and Nb-base alloy parts against oxidation consists in preparing a coating slurry, essentially of aluminum and chromium powder in the proportion of 90 wt % Al + 10 wt % Cr, and fluoride-glass powder consisting of 60 wt % LiF + 3.2 wt % CaF$_2$ + 17.6 wt % AlF$_3$ + 19.2 wt % NaF, coating the parts to be protected with the slurry, drying the coated parts at 250 to 300°F for about 30 minutes, curing for one hour at 1800 to 1900°F, applying a coating of sealing glass, and curing at 1400 to 1800°F. (auth)

Preparation and Fabrication

Refer also to abstracts 26434, 27055, 27064, 27068, 27091, 27099, 27103, and 27106.

27000 (ORNL-tr-2113) DISTRIBUTION OF UNIFORM PRESSURE ON THE CONTACT ARC OF METAL WITH THE ROLLS. Bazan, J. Translated for Oak Ridge National Lab., Tenn., from Arch. Hutn., 13: 55-76(1968). 21p. Dep. CFSTI.

A solution of the Karman differential equation on the basis of up to date investigations concerning the openings between the bodies of rolls is given. Prior to a particular solution of the general equation, an additional equation was assumed resulting from the shape of the tool, mechanical properties of the metal and the existing friction on the contact surface of the metal with the rolls. The contact arc was replaced by a chord of equations, and the parabolic strength strain hardening of the metal was assumed. The possibility of appearing in the retardation zone as in the forward creeping zone, of three subzones of friction including the slipping, contacting, and dead zone was assumed. Variations of the friction force values in the individual subzones are given. The substitution of additional equations enables a general solution, and after the substitution of boundary conditions —a particular solution. Five formulas were obtained for calculating the unitary pressure: for the slip, the contacting and the dead zone. In order to facilitate the application of the derived formulas, and to present a comparison, an example was solved by calculating the unitary pressure distribution along the contacting arc of the metal with the rolls. (tr-auth)

27001 (RFP-972) VACUUM COATING OF BORON NITRIDE. Kurtz, Robert G.; Van Vorous, T. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Apr. 18, 1969. Contract AT(29-1)-1106. 8p. Dep. CFSTI.

A method has been developed to deposit adherent metal films on boron nitride. The procedure utilizes thin (about 500 angstroms) film of beryllium deposited by ion plating techniques directly onto the boron nitride. Films of other metals may then be deposited over the beryllium film by any convenient method. Thorough substrate cleaning and outgassing prior to the start of the deposition process are essential for good film adherence, as well as substrate heating before and during the deposition. (auth)

27002 (RFP-1295) VACUUM ACCELERATED-ION DEPOSITION. Kurtz, Robert G.; Van Vorous, T. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Apr. 17, 1969. Contract AT(29-1)-1106. 8p. Dep. CFSTI.

A new evaporation technique has been investigated which utilizes the thermal energy of a resistance source to ionize, either directly or indirectly, an evaporant metal placed in the source. The ionized evaporant is accelerated towards a substrate by placing a high negative potential on the substrate. Not all metals exhibit this ability to be ionized. Of twenty-two metals investigated, only nine showed measurable current during evaporation. (auth)

27003 (Y-1612) CHEMICAL MILLING OF BERYLLIUM. Anderson, R. C.; Ludwig, R. L. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Mar. 8, 1968. Contract W-7405-eng-26. 11p. Dep. CFSTI.

Chemical milling of beryllium ingot sheet was investigated as an inexpensive, alternate method for producing the radiative fins for the SNAP-27 Radioisotope Thermoelectric Generator. Fin specimens were submerged in a sulfuric acid bath maintained at a constant temperature, then slowly rotated while being withdrawn from the bath at a constant rate of speed. This procedure should have produced uniformily tapered fins within a reasonable length of time. However, there were variations in the taper due to the nonuniform thickness of the hot-rolled beryllium sheet and a preferential attack at the rolling defects in the beryllium sheet. (auth)

27004 DESCALE METALLIC PARTS MORE RAPIDLY IN MOLTEN SALT BATHS. Wick, C. H. Mach. Mod., 62: 25-9 (Oct. 1968). (In French).

Molten salt baths can be used to clean, descale and degrease a large number of metals in a single operation, producing a very uniform surface with no pitting or H_2 embrittlement. Recommendations for using reducing, oxidizing or electrolytic salt baths are given, according to the number and type of part, the metal composition, the type of surface contamination and the required production rate. High-temperature oxidizing salt baths are recommended for difficult-to-descale stainless steels and for tools hard surfaced with tungsten or chromium oxides, aluminum oxides or W. Intermediate temperature baths are used for hollow forged parts, small dia. tubes and parts with narrow internal passages. A bath at 425 to 450°C is recommended for Mo and its alloys. A low-temperature (200 to 220°C) bath is available for hot rolled and heat treated Ti and Ti alloy parts. Electrolytic salt baths are used to descale cast iron, all steels and other ferrous alloys. (Metals Abstr.)

27005 VACUUM EXPERIMENTAL CASTINGS OF URANIUM: TESTS OF SOLIDIFICATION RATE CONTROL. Guichard, Claude; Soret, Jean Claude (Societe Industrielle de Combustible Nucleaire, Isere, France). Vacuum, 19: 175-7(Apr. 1969).

Equipment and procedure are described for the vacuum melting and casting of low-alloyed uranium into tubes weighing about 40 kg each. The results of tests are presented and the important design parameters are derived. The method is expected to be applicable to metals having high gas content or high vapour pressure which are unsuitable for electron beam melting. (auth) (UK)

27006 APPLICATIONS OF ELECTRON BOMBARDMENT [IN REFINING AND WELDING]. Met. Constr. Mec., 100: 506-8 (Oct. 1968). (In French).

Electron bombardment is used industrially for both melting and welding. Tantalum, Nb, Si and Hf are particularly suitable for electron bombardment refining since Sb, Mn, Al, Fe, Na, Pb and Sn are almost eliminated. Two types of furnaces are described, a furnace with a simple annular cathode and a Pierce gun furnace with feed hopper. Electron bombardment welding can join Cu to Ti, Al to stainless steel and other dissimilar metal combinations. The heat affected zone is very small so that stresses are low, centered in the weld zone and easily removed by heat treatment. Thick parts can be welded with no risk of contamination. Unusual configurations can be welded, such as those found in nuclear fuel elements. Electron beam machining is used for hard materials such as W and WC. (Metals Abstr.)

27007 ALUMINUM AND ELECTRIC POWER. Lugagne, P. Rev. Fr. Energ., No. 200, 314-24(Apr. 1968). (In French).

A method of producing aluminum is discussed. A description of an electrolytic tank (cathode crucible and anode device) and how it operates is given. The economics were studied of aluminum production in various countries in terms of the cost of electric power, which is one of the raw materials going into this product. The policies practiced by French aluminum producers and the production trends in France are discussed. An outline is given of the prospects of aluminum production within the context of its potential use in nuclear power stations. (Sum. Articles Fr. Tech. Press)

27008 HIGH-TEMPERATURE FORGE FOR REFRACTORY METALS. Habermann, C. E.; Rafalski, A. L.; Hansen, R. D. (Dow Chemical Co., Midland, Mich.). J. Less-Common Metals, 18: 105-9(June 1969).

A laboratory-sized forge was designed and constructed which can forge samples in situ at a controlled temperature, in a protective atmosphere, to a predetermined amount of deformation. A maximum temperature of 1800°C can be attained in 2 to 3 min, which reduces grain growth in the sample to a minimum. The controlled atmosphere prevents oxidation of refractory metals during operation. This piece of equipment has been used to determine the high-temperature formability and ductility of refractory metals. (auth)

27009 THE PROPERTIES OF NIOBIUM CRYSTALS PRODUCED BY ZONE-MELTING. Kim, H. C.; Pratt, P. L. (Imperial Coll., London). Mater. Res. Bull., 2: 323-35(1967).

From International Conference on Characterization of Materials, University Park, Pa. See CONF-661126.

The effects of the number of passes, the zone speed and direction, and the vacuum pressure during zone melting of niobium were evaluated by measurements of electric resistivity ratio, hardness, and yield stress, and by strain aging experiments and chemical analysis. High zone speeds resulted in a significant increase in the effective distribution coefficient in the zone leveling process. The most important contribution to purification was found to be the vacuum pressure in the furnace during melting. The carbon and nitrogen contents were reduced with increasing number of zone passes, and this may be associated with the lower yield stress and less marked discontinuous yielding behavior. (auth)

27010 INFLUENCE OF OXYGEN ON ZIRCONIUM PROPERTIES AT HIGH TEMPERATURES. Kornilov, I. I.; Glazova, V. V.; Kenina, E. M. At. Energ. (USSR), 26: 324-7(Apr. 1969). (In Russian).

The solubility of O in Zr–O systems is 7 at. %. Results of measurements of hot hardness, elasticity, and bend tests and calculations based on elastic deformation rates showed that addition of oxygen to zirconium resulted in increase of Zr–O system high temperature strength for the studied compositon range and increased the strength of interatomic bonding in these alloys. (auth)

27011 GAUSSIAN-LIKE MELTING [FRONT] OF METALS [MELTED] BY AN ELECTRON BEAM. Zuev, I. V.; Rykalin, N. N.; Uglov, A. A. Fiz. Khim. Obrab. Mater., No. 5, 7-15 (Sept.-Oct. 1968). (In Russian).

The mechanism responsible for the Gaussian-like shaped melting of metals subjected to intense electron beams is discussed theoretically and on the basis of experimental data relating to Si, Al, Ti, Cu, Ni, W, and stainless steels. The characteristic features of this kind of melting may be explained on the basis of a "thermal explosion" created by volume heat sources. The conditions required to produce hole formation under the impact of the electron beam depend both on the intensity of the latter and the properties of the particular metal. Deep melting may also be realized for other concentrated sources of energy subject to due modification of the conditions. (Metals Abstr.)

27012 REQUIREMENTS IMPOSED ON ELECTROLYTES USED FOR THE ELECTROCHEMICAL MACHINING OF METALS.

Volkov, Yu. S.; Moroz, I. I. Fiz. Khim. Obrab. Mater., No. 5, 63-7(Sept.-Oct. 1968). (In Russian).

The various requirements imposed on electrolytes intended for the electrochemical machining of metals, e.g. high solubility and a large positive value of the equilibrium potential of the anions, are discussed theoretically. These requirements must be satisfied if the machining of the metal is to take place stably and efficiently. A method of choosing the best electrolyte for the machining of various common metals is proposed. The theory is borne out by practical experience with W, Ti, and Mo. (Metals Abstr.)

27013 NEW FORGING TECHNIQUES FOR BERYLLIUM. Glenn, George (Air Force Materials Lab., Wright Patterson Air Force Base, Ohio); Hayes, Arthur F. Metal Progr., 95: No. 3, 131; 133; 135; 137; 139(Mar. 1969).

By the use of forging techniques instead of vacuum hot-pressing methods, beryllium parts so produced have 50% higher yield strength, improved ductility in selected directions, and greater material utilization. Methods for forming beryllium metal into cylinders, rings, shafts, and discs are discussed. The metal was supported during the forging by various restraint techniques. (auth)

27014 COMPACTING AND PRESSURELESS SINTERING OF BERYLLIUM POWDERS. Moberly, J. W.; Goggin, W. R.; Brown, H. M. (Stanford Research Inst., Menlo Park, Calif.). Int. J. Powder Met., 5: No. 2, 63-76(Apr. 1969).

Experimental parameters are discussed for the fabrication of dense beryllium billets by a technique consisting of cold hydrostatic pressing followed by pressureless sintering. Billets from commercial beryllium powders have been prepared with densities greater than 98% of theoretical values and with mechanical properties comparable to those of hot-pressed beryllium, which exhibits a high degree of structural homogeneity and no measurable increase in impurity levels. Hardness, density, and grain size data are documented as functions of sintering temperature. (auth)

27015 THE PERMALLOYS: Ni–Fe–Mo ALLOYS HAVE HIGHEST INITIAL PERMEABILITY. Moly Pays Off, 1: No. 1, 14-15(May 1968).

Data are reported on heat-treating methods and magnetic characteristics of the family of Fe–Mo–Ni alloys termed Permalloys. (P.G.C.)

27016 PREPARATION OF A DIFFUSION-COATED NIOBIUM ALLOY FOR OPTICAL METALLOGRAPHY. Dainty, R. V.; Trenouth, J. M.; Whelan, E. P. (National Research Council, Ottawa). Metallography, 1: 459-62(Jan. 1969).

Procedures used in preparing, for optical metallography, a Nb–Mo–V–Zr alloy, diffusion coated with Cr–Ti, which combines acceptable coating retention and minimum edge rounding are described. (P.G.C.)

27017 CORRELATION OF ORIENTATION AND POLARIZED ETCHING FACETS IN A MAGNESIUM ALLOY. Wells, T. C.; Lavin, P. A.; Manthorpe, D. (International Research and Development Co. Ltd., Newcastle upon Tyne, Eng.). Metallography, 1: 449-53(Jan. 1969).

Methods for polishing and etching a Mg alloy to develop grain structure and produce facets of the basal plane in each grain are described. The facets were found to be critically dependent on grain orientation, as a direct result of fabrication procedure, and their response to polarized light may be used as a measure of crystal orientation. (P.G.C.)

27018 REPLICATION OF IRRADIATED MATERIALS. Miller, John L. Jr. (Oak Ridge National Lab., Tenn.). Metallography, 1: 443-7(Jan. 1969).

Methods are described for replication of radioactive sample surfaces for examination by electron microscopy. (P.G.C.)

27019 A SIMPLIFIED RESIN-IMPREGNATION METHOD OF SPECIMEN MOUNTING. Vanark, Robert J. Sr. (Allis-Chalmers Mfg. Co., Milwaukee). Metallography, 1: 439-41 (Jan. 1969).

Techniques for mounting porous materials, fragile particles, crystals, oxide layers, and thin platings for microscopic examination are described by which specimens are impregnated with epoxy resin contained in a non-adhering Teflon tube. (P.G.C.)

27020 PREPARATION OF BERYLLIUM FOILS FOR TRANSMISSION ELECTRON MICROSCOPY. Grotzky, V. K.; Fraikor, F. J. (Dow Chemical Co., Golden, Colo.). Contract AT(29-1)-1106. Metallography, 1: 431-5(Jan. 1969).

A chemical saw was developed to cut strain-and-deformation free specimens of Be for electron-microscopy structure studies. (P.G.C.)

27021 A NEW PROCEDURE FOR REVEALING THE MICROSTRUCTURE OF α-PLUTONIUM. Renecken, D. G. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. Metallography, 1: 365-72(Jan. 1969).

A new electrolytic polishing and etching technique that produces sharply delineated grain boundaries in α-plutonium — visible under bright-field illumination — is described. It is shown that the microstructures obtained by this technique reveal more detail than is generally obtained by other techniques. The technique, utilizing an optical electropolisher–etcher, can be applied directly to as-machined surfaces, thereby eliminating the mechanical grinding and polishing stages normally employed. Specimens are satisfactorily electrolytically polished at 3.0 Å/cm^2 for 10 to 30 seconds in a solution of 10% nitric acid, 20% ethylene glycol, and 70% methanol, and electrolytically etched at 30mÅ/cm^2 for 1.5 to 3 minutes. (auth)

27022 METALLOGRAPHIC PREPARATION OF BERYLLIUM. Calabra, Arthur E.; Marts, Don L.; Capes, James F.; Jackson, Ross J. (Dow Chemical Co., Golden, Colo.). Contract AT(29-1)-1106. Metallography, 1: 311-32(Jan. 1969).

Three methods developed for the metallographic preparation of both powder-pressed and vacuum-cast, ingot-sheet beryllium are described. One method is a rapid, economical electrolytic procedure for polarized-light observation of routine samples. A second method is a mechanical, etch–polish procedure that yields the highest-quality results and is suitable for research-oriented studies. Another method is an electrolytic swab-etch–probe procedure that allows nondestructive observation of large components and in addition yields a bright-field etch. The effects that improper preparation can have on the resulting microstructure are discussed. (auth)

27023 MECHANISM OF JOINT FORMATION IN THE SOLID-STATE WELDING OF NIOBIUM/ALUMINIUM OXIDE COMPOSITES. Karakozov, E. S.; Kotelkin, A. S.; Matveev, G. M.; Merkulov, V. A.; Shorshorov, M. Kh. Fiz. Khim. Obrab. Mater., No. 3, 123-9(May-June 1968). (In Russian).

The kinetics of the process of joint formation in the solid-state welding Nb to Al_2O_3 ceramics were studied theoretically and experimentally. The time taken for physical contact to develop between the metal and the ceramic was estimated on the basis of the creep characteristics of Nb; complete physical contact took place at 1500°C and a pressure of 1.5 kg/mm^2 after ~1000 sec. From the thermodynamic point of view, 1500°C was sufficient for the formation of an actual chemical compound between the Nb, Al, and O. The contact between the components of such welds was completely vacuum-tight. (Metals Abstr.)

27024 THERMIONIC PROPERTIES OF ALLOYS BELONGING TO THE TUNGSTEN–LANTHANUM OXIDE SYSTEM. Kondratov, I. Ya.; Podchernyaeva, I. A.; Samsonov, G. V.; Fomenko, V. S. Elektron. Obrab. Mater., No. 3, 65-70(1968). (In Russian).

The phase composition and physical properties of a number of alloys belonging to the $W-La_2O_3$ system obtained by the hot-pressing method were studied and discussed in the light of the latest theories of the electron structure of metals. Special attention was paid to the thermionic emission of the alloys and its relation to the structure and other physical characteristics. The presence of traces of C greatly reduced the thermionic emission of the alloys. The reasons for this reduction are considered on the basis of the theory of electron exchange between adsorbed atoms and the main body of the material. (Metals Abstr.)

27025 CORING BLIND HOLES IN SMALL URANIUM CASTINGS. Edelman, R. E.; Saia, A. (Frankford Arsenal, Philadelphia). Mod. Cast, 54: 82-4(July 1968).

A method of casting blind holes, with a large length-to-dia ratio, into a depleted U–8% Mo alloy shape is described. The castings were sound and both the outside and inside dia were smooth. The hardness, which can be used as a measure of contamination, was similar to that obtained on other castings known to be free of contamination. A new rammable graphite material was used to make both the cores and the molds. (Metals. Abstr.)

27026 THE EXPERIMENTAL RESEARCHES ON THE BRITTLENESS DUE TO THE HEATING HISTORY IN MANUFACTURE AND THE RADIOGRAPHIC INSPECTION OF THE PART FITTED WITH NOZZLE OF THE REACTOR PRESSURE VESSEL. Yosetsu Gijutsu, 16: No. 12, 69-78(Dec. 1968). (In Japanese).

Tests of strength, brittle fracture, and fatigue for reactor pressure vessel steels were made on test plates subjected to hot-pressing, welding, and stress relieving annealing. A destruction test of a model pressure vessel was made. The test plates were of A302B 20 and 100 mm thick. A method of radiographic inspection was established for the part of the pressure vessel which was fitted with a nozzle. Effects of the heating history in the manufacture of the steels were evaluated and information regarding safety in design and fabrication of the pressure vessel was obtained. As a result of the investigation into changes in hardness and structure due to stress relieving annealing, it was found that an annealing temperature below the Ac_1 transformation point and about 630°C was desirable. (P.G.C.)

27027 FORMATION AND MECHANICAL PROPERTIES OF WELDS BETWEEN ZIRCONIUM, TITANIUM, AND NIOBIUM PRODUCED BY ARGON-ARC WELDING. Novosadov, V. S.; Shorshorov, M. Kh. Fiz. Khim. Obrab. Mater., No. 2, 92-100(Mar.-Apr. 1968). (In Russian).

The mechanisms responsible for the formation of Ar-arc welded joints between Zr, Ti, and Nb were studied and the mechanical properties of the welds were determined. Formations developing on the side of the more refractory metal in any particular pair were attributed to high-temperature dissolution processes. The processes in question depended on the geometrical conditions governing the turbulent flow of molten metal in the course of welding. An efficient method of studying the mechanical properties of such welds is described. (Metals Abstr.)

27028 SURFACING MATERIAL. **Frumin, I. I.; Golovashchuk, A. I. Russian Patent 224,290. (In Russian).**

A surfacing material produced by powder metallurgy in the form of tape is described. The material includes nickel and molybdenum. The resistance of the surfaced metal to sulfuric or formic acids is increased by addition of molybdenum in amounts of 32 to 37 wt % with nickel constituting the remaining part of the material. Ferrovanadium is also suggested as an additive in amounts up to 5%. (JPRS)

27029 CONDITIONS FOR OBTAINING HIGH STRENGTH, HIGH MELTING COATINGS BY SPRAY DEPOSITION IN A JET OF HIGH TEMPERATURE PLASMA. **Gladkovskii, V. A. Fiz. Khim. Obrab. Mater., No. 3, 147-8(1968). (In Russian).**

Results of a study of plasma spray deposition of tungsten and aluminum oxide are given. A method was developed for spray deposition of coatings of different thickness on carbon steel and titanium. In plasma spray deposition, properties of the coatings depend to a high degree on the velocity of the particles. In the experiments, variations were made in arc voltage, current strength, distance of the backing from the nozzle, feed rate of the powder, and size of the arc gap, maintaining other parameters constant. The experimental results were: density (%)–tungsten 83 to 85, aluminum oxide 80 to 90; coefficient of linear expansion (°C)–tungsten 5.5×10^{-6}, aluminum oxide 7.4×10^{-6}; microhardness (kg(force)/mm^2)–tungsten 290, aluminum oxide 2000; rupture strength (kg(force)/mm^2)–tungsten 25, aluminum oxide 0.7 to 1.2; bending strength (kg(force)/mm^2)–tungsten 5.9 to 6.4; compression strength (kg(force)/mm^2)–aluminum oxide 250. It is observed also that tungsten coatings applied by spray deposition of powders lead to an increase in the limiting durability of carbon steels and to an increase in their limiting service life under cyclic stresses. (JPRS)

27030 ELECTRON-BEAM WELDING OF MOLYBDENUM TO NIOBIUM AND MOLYBDENUM TO Kh18N10T STAINLESS STEEL. **Terebikhin, G. V. Tr. Leningrad. Politekh. Inst., No. 283, 157-64(1967). (In Russian).**

To investigate electron-beam welded joints of molybdenum with niobium, holes 1 mm in diameter and 6 mm deep were drilled in the end face of a molybdenum rod 12 mm in diameter, and niobium wire 1 mm in diameter was pressed into the holes with a tight fit to a depth of 2 to 2.5 mm at a distance of 3 mm from the rod end face. The assembled joints were degassed, preheated for a short time, welded in a vacuum of $1 \cdot 10^{-4}$ mm Hg and cooled in a vacuum for not less than 7 min. Welding proceeded smoothly without spattering and with satisfactory formation of the weld. Strong welds were obtained only if the wire was fitted tight in the holes. In tensile tests done by pulling the wire, failure, as a rule, occurred along the base metal-niobium wire, at a distance of 5 to 10 mm from the weld. The wire sustained 2 to 3 bends both before and after welding. The metal in the heat-affected zone had a coarse-grained microstructure with a 340 HB microhardness at the fusion zone center. The presence of an intermediate layer with higher hardness and strength induced no cracking, and the strength indices of the joints were satisfactory. Examination of an electron-beam welded lap joint in a molybdenum rod with a tight-fitted ring of Kh18N10T stainless steel 1.5 mm thick, revealed the formation of an intermediate layer with more complex chemical composition and properties than those formed in welding molybdenum to niobium. The intermediate layer had a microhardness of HB824 at the outer surface and HB220 at the inner surface adjacent to molybdenum. This led to the formation of cracks along the intermediate layer–molybdenum boundary. In the heat-affected zone, molybdenum was recrystallized and had a coarse-grained structure which was brittle at room temperature. The joints failed at the intermediate layer at a stress of 15 kg/mm^2. Preliminary plating of molybdenum with a 15 μ thick layer of nickel at the spot of welding, and subsequent welding under conditions which excluded melting of molybdenum, yielded sound helium-tight joints with a tensile strength of 45 kg/mm^2. Similar satisfactory results were also obtained by electron-beam brazing with a PZhK-35 brazing alloy strip wrapped around a molybdenum rod underneath the steel ring. The PZhK-35 brazing alloy is a heat and corrosion resistant nickel-base alloy melting at 1200°C, supplied in the form of strip according to TU287-61 specifications. (JPRS)

27031 HOT ROLLING OF TITANIUM ALUMINUM NIOBIUM ALLOY. **Kachaynik, O. I. Tr., Mosk. Aviats. Tekhnol. Inst., No. 68, 116-21(1967). (In Russian).**

Progress was made in the development of plate rolling technology from a Ti–Al–Nb alloy. The rolling conditions were analyzed and the power energy parameters determined. The mechanical properties of the hot-rolled stock are presented. It was established that this plate rolling technology will make it possible to produce material with specified mechanical properties and structure. (JPRS)

27032 [FABRICATION OF] TUBULAR METAL PARTS. **LeFiell, C. K. Mach. Design, 40: 152-8(Dec. 5, 1968).**

Stock tubing is available in welded, welded and redrawn, and seamless types in a large range of sizes, wall thickness and materials. Special seamless tubing can be produced to aircraft and nuclear specifications from Rene 41, Hastelloy, Ni, TD Ni, 4130 steel, Vascojet 1000, 347 stainless, 7075 and 7079 Al alloys, Ta, Mo, Nb, Ti–6Al–4V, TZM, Zr, V, 17-4 PH stainless, and Waspaloy. Recommendations for forming tapered diameter parts, variable-wall parts noncircular parts, flared, flanged and expanded parts and tube-end closures are given. Redrawing, step-drawing, bending and assembly operations are described. (Metals Abstr.)

27033 SPECIAL METALS [SPECIAL STEELS AND ZIRCONIUM ALLOYS] MEET THE CHALLENGE OF THE MATERIALS AGE. **Esso Oilways, 16: No. 4, 8-10(1968).**

Activities of the Swedish Sandvik Corporation are outlined with a special reference to development, fabrication, and use of Zr alloys as nuclear-reactor structural and fuel-cladding materials, and of corrosion-resistant extra-low-C steels for heat exchangers. (Metals Abstr.)

27034 ADVANCES IN THE DIE CASTING OF COPPER ALLOYS. **Schetky, L. McD. Giessereipraxis, No. 12, 205-14 (June 20, 1968). (In German).**

The selection of die materials in the die casting of brass is discussed and experiments with Mo and W alloys as die materials are described. Brass alloys containing 59% Cu, 1.75% Pb, 0.20%, Sn, 0.1 to 0.2% Al, remainder Zn were cast at a rate of 1.5 castings/min, at 927°C and a casting pressure of 1300 kg/cm^2. Comparative testing of H-13 tool steels, the TZM and GE-22 Mo alloys, and W showed that sintered W alloy is the most suitable material. Lifetimes of 56,000 castings were obtained with a single die, together with good surface properties. A brief description of the Acurad process is presented. (Metals Abstr.)

27035 A STUDY OF JOINT ZONES IN THE EXPLOSIVE WELDING OF METALS. **Berdichevskii, G. I.; Sobolenko, T. M. Avtomat. Svarka, No. 9, 13-17(Sept. 1968). (In Russian).**

X-ray microanalysis was used to study the transition zones formed during explosive welding of Cu/Fe, Cu/Nb, Fe/Ti, Ti/Nb, and Nb/Zr. The distribution of the elements in the joint zone directly after explosive welding was independent of the mutual solubility of the components. 7 references. (Metals Abstr.)

27036 ELECTRICAL MACHINING. PART VII. ROLE OF AMPERAGE, VOLTAGE AND CAPACITANCE. **Davis, Malcolm; Foertmeyer, Evans. Mod. Mach. Shop, 41: 120-5(Oct. 1968).**

The current direction in EDM is important because the relative wear between tool and workpiece depends on the respective polarities. Excessive inductance between power source and gap is generally undesirable because of its effect on the metal removal rate. The power source should be a low impedance source. In electrochemical machining and electrolytic grinding, the metal removed is directly proportional to the amount of current flow. Values of current density required for a given penetration rate are shown for Fe, Ni, Co, Al, Ti, Mo, W, Cr, Cu and Nb. Direct current is used in normal ECM and ELG processes although the current may be reversed for short periods of time to wash out machined products and remove metal that has been plated out on the tool. Pressure controllers and short circuit detecting devices are available. (Metals Abstr.)

27037 DIFFUSION WELDING OF TITANIUM ALLOYS AND COPPER OR COPPER ALLOYS WITH MOLYBDENUM OR NIOBIUM INTERLAYERS. **Bobrov, G. V.; Dolgov, Yu. S.; Privezentsev, V. I.; Strizhevskaya, L. G.; Shmakov, V. M. Svar. Proizv., No. 11, 16-17(Nov. 1968). (In Russian).**

The specimens, 15 mm dia × 30 mm, subjected to diffusion welding were made from Ti alloys OT 4 and VT 14, M1 grade Cu, and BrKh08 bronze. Mo and Nb sprayed coatings and foil were used as interlayers. The materials form a continuous series of solid solutions with Ti. Mo scarcely interacts at all with Cu, but there is evidence that by diffusion welding, a compound of Cu and Mo is formed which has the same strength as Cu. Atomization of the interlayer was obtained using a neutral wire, and grade-A Ar to GOST Standard 10157-62. Diffusion welding was carried out on vacuum equipment with h-f induction-heating and hydro-mechanical compression, and also in an evacuated container with a pneumatic compression device and heating in a furnace. The vacuum equipment was used for comparatively short time cycles up to 30 min; cycle times up to 7 hr were used with the container. The specimens were subjected to metallographic analysis, microhardness measurement and rupture tests. Diffusion welding of Ti and its alloys with Cu, by using a sprayed interlayer, was possible. Techniques were developed for atomizing the Mo and Nb on to the Ti alloy specimens, subsequent heat treatment, and diffusion welding specimens without an interlayer, using foil inserts and interlayers of sprayed metal. (Metals Abstr.)

27038 MOLECULAR PLATING. VI. QUANTITATIVE ELECTRODEPOSITION OF AMERICIUM. **Getoff, N.; Bildstein, H. (Osterreichische Studiengesellschaft fuer Atomenergie Gmbh, Vienna). Nucl. Instrum. Methods, 70: 352-4(May 1, 1969).**

A new application of the molecular plating method for the electrodeposition of americium is described. The deposition yield was investigated as a function of the water content in the americium-iso-propanol system as well as of the various additives and of the duration time. A quantitative deposition can be achieved by using a small amount of aqueous americium nitrate (10 μl) in iso-propanol (10 ml) for a deposition time of 70 min at 300 V and 5 mA. The same result is obtained for a shorter time (55-60 min), when 10 μl 10^{-3} $\underline{M}$ $RbNO_3$ solution is added to the electrolyte. In both cases the americium films are extremely uniform and with a very good adhesive strength. (auth)

27039 STAINLESS WELDING MEETS STRINGENT TEST ON HEAVY WATER PLANT. Can. Mach. Metalwork., 79: 66-7 (May 1968).

Stainless steel distillation trays for a heavy water plant are fabricated using the short-arc, Linde spray-arc and Linde Mig spot welding processes. Distortion was eliminated by using strict welding sequences and a 0.030-in. diameter E308L filler wire. The short-arc process (using Linde A 1025 gas mixture) was four times faster than conventional methods. The high welding speeds kept shrinkage to a minimum. The spot welds were subjected to destructive testing and x-ray testing with good results. (auth)

27040 MAGNESIUM WROUGHT ALLOY FOR ULTRASONIC DELAY LINES. **Drits, M. E.; Sviderskaya, Z. A.; Rokhlin, L. L.; Tarutin, N. P.; Gur'yev, I. I.; Dronova, N. P.; Khodakov, P. E.; Solov'eva, V. V. Russian Patent 222,669. (In Russian).**

A magnesium wrought alloy, alloyed with manganese for use in ultrasonic delay lines is discussed. To improve sound conductance and technological properties, the composition of the alloy is set as follows: 0.5 to 2.0% cerium, 0.15 to 0.6% manganese and remainder magnesium. (JPRS)

27041 STATE OF THE ART IN THE CONSOLIDATION AND PRIMARY WORKING OF REFRACTORY METALS. Mahla, E. M. (E. I. DuPont de Nemours and Co., Wilmington, Del.). Met. Soc. Conf., 34: 236-48(1966).

From Conference on High Temperature Refractory Metals, New York. See CONF-524-(Pt. 2).

Practices in the consolidation and primary working of the refractory metals are described. All the metallurgical reactions that occur in these materials are of a classical nature. The major complexities arise from the difficulty of adapting standard metal working tools and facilities to the temperatures dictated by the high melting points of the refractory metals and from their reactivity with refractories and interstitial elements at such high temperatures. The current status and limitations of the following consolidation operations are described: hydrostatic compaction and sintering, vacuum consumable arc melting, electron beam melting, and shape casting. The goals of primary working are examined and the success of extrusion, forging, and direct rolling of cast slabs in meeting these goals is appraised. (auth)

27042 THE InFab PROCESSING OF REFRACTORY METALS AT HIGH TEMPERATURES. Bianchi, L. M.; Bonchak, John; McElhaney, W. J. (Universal-Cyclops Steel Corp., Bridgeville, Pa.). Met. Soc. Conf., 34: 249-63(1966).

From Conference on High Temperature Refractory Metals, New York. See CONF-524-(Pt. 2).

The InFab facility was built to make available for experimental and pilot lot production a facility capable of working refractory metals at their true hot working temperatures in a protective atmosphere. A review of the information obtained so far on the utilization of high temperatures to ease the deformation of refractory metals in their primary and secondary fabrication is reviewed. These data are applied to Mo and Nb alloys and the amount of deformation obtained as a function of the deformation temperature is considered. A second item that is covered is the evaluation of the data on the contamination of refractory metals during their exposure and processing at high temperatures in the InFab atmosphere. Correlations with the degree of contamination and results of analyses of the InFab atmosphere are presented. Methods associated with the attainment of high purity atmospheres in an environment which involves equipment and man entry are discussed along with equipment lubrication problems. (auth)

27043 PARAMETERS PERTINENT TO PURIFICATION BY ELECTRON BEAM ZONE REFINEMENT. Drangel, I.; Murray, G. T. (Materials Research Corp., Orangeburg, N. Y.). Met. Soc. Conf., 34: 264-85(1966).

From Conference on High Temperature Refractory Metals, New York. See CONF-524-(Pt. 2).

A study was made of the effect of several processing parameters on the resulting purity of electron beam refined molybdenum and tungsten. The variables investigated included zoning speeds, number of passes, emitter configuration, type of vacuum system employed, and starting material type and composition. Resistivity ratio measurements, i.e., R 298°K/R 4.2°K have been used to evaluate these variables. In some cases selected specimens were chemically analyzed. It has been found that increasing the number of zone passes and reducing the zone speed does not always result in higher purity material. The effect of these two important parameters can often be masked by the type of starting material and efficiency of the vacuum system. If these latter experimental factors be properly controlled then significant improvement is noted with increasing number of passes and reduced zoning speeds. (auth)

Properties Evaluations

Refer also to abstracts 26471, 26480, 26486, 26487, 26501, 26989, 26994, 27014, 27024, 27026, 27029, 27124, 27138, 28467, 28486, 28487, 28598, 28632, and 28641.

27044 (AI-AEC-12788) MECHANICAL BEHAVIOR OF TYPE 304 STAINLESS STEEL IN COPPER-CONTAMINATED SODIUM IN THE RANGE 950 TO 1300°F. Atkins, D. F. (Atomics International, Canoga Park, Calif.). Apr. 1, 1969. Contract AT(04-3)-701. 30p. Dep. CFSTI.

Biaxial stress-rupture tests on Type 304 stainless steel tubing were performed in static Na retorts at 950, 1100, and 1300°F. Pure Cu tabs were immersed in the Na to provide a Cu-saturated condition throughout the test duration. Results were compared with identical tests in Cu-free Na. Charpy impact specimens, exposed to the Na–Cu environment during the stress rupture tests, were subsequently tested at −75°C. It was found that the presence of Cu in sodium did not influence the stress rupture behavior and impact strength of 304 stainless steel at temperatures up to 1300°F. Although testing at 1300°F did not exceed 1200 hours, microstructural examinations indicated that much longer exposures could be tolerated. No serious penetration of Cu into the stainless steel was observed. Cu dissolved in Na was found to deposit on the stainless steel in the isothermal region of the 950°F static Na test, but at 1100 and 1300°F, Cu deposits occurred only in regions where the Na bath was slightly cooler. No Cu was found in the Na vapor regions of the retorts. (auth)

27045 (BARC-377) DIFFUSION OF MOLYBDENUM AND CERIUM IN BETA-ZIRCONIUM. Paul, A. R.; Anand, M. S.; Naik, M. C.; Agarwala, R. P. (Bhabha Atomic Research Centre, Bombay (India)). 1968. 12p. Dep.

Diffusion of molybdenum and cerium in beta zirconium was studied by residual activity technique in the temperature range of 880 to 1600°C. The results show a non-linearity in the plots showing temperature dependence of diffusivities as observed in the self and impurity diffusion of niobium and vanadium in beta-zirconium and low values of D_0 and Q in the low temperature range. On the basis of dual mechanisms operating, the diffusivities (D cm^2/sec) in the above cases could be expressed as a sum of two exponentials: $D_{Mo/\beta\text{-}Zr} = 1.99 \times 10^{-4} \exp(-1.53\ eV/kT) + 2.63 \exp(-2.97\ eV/kT)$; $D_{Ce/\beta\text{-}Zr} = 3.16 \times 10^{-2} \exp(-1.80\ eV/kT) + 42.17 \exp(-3.22\ eV/kT)$. The non-linearity in the Arrhenius plots has been explained on the basis of (i) extrinsic defects being introduced by the presence of residual impurities, (ii) enhancement due to the randomly oriented dislocations and (iii) vacancy-divacancy model. (auth)

27046 (EUR-4101, pp 193-210) EVALUATION OF THE TENDENCY TO FRACTURE IN MATERIAL UNDERGOING IMPULSIVE LOADING USING SMALL SPECIMENS. Van Elst, H. C. (Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Delf).

Cylindrical specimens, 6 mm in dia and length, were impact tested under controlled temperature conditions by impulse loading from detonation of an explosive. The test equipment and method are described. Energy absorption data for several types of steel specimens are presented which show the flux dependence of neutron irradiation effects on the energy absorption for a given specimen at temperatures from −50 to 200°C. Dynamic stress-strain diagrams at −50 and 150°C are presented for one aluminum and two steel specimens. (L.C.L.)

27047 (EUR-4101, pp 217-20) EFFECT OF STRAIN RATE ON FRACTURE STRENGTH OF CONVENTIONAL STRUCTURAL STEELS. Pellini, W. S. (Naval Research Lab., Washington, D. C.).

A discussion is presented of the factors, principally temperature, local cracking or flaws, and level of loading, that influence the fracture toughness of structural steels subjected to dynamic loads. (L.C.L.)

27048 (EUR-4101, pp 305-23) EXPLOSION TESTS OF ARC WELDED STEEL TUBES. Kihara, H.; Iida, K. (Tokyo Univ. (Japan)).

A series of explosion tests were carried out on 18 arc welded tube specimens made of mild steel and three kinds of high tensile steels to investigate the effects of material, welding method, stress annealing, low-temperature stress relieving, and peening on the fracture behavior of the tubes. The testing equipment and procedures are described. It was concluded that: when the circumferential strain reached a certain value in a specimen, fracture occurred and was independent of the weight of explosive charge; 50 HT, high tensile steel was the most fracture resistant, followed by quenched and tempered 60 HT steel, and mild steel; stress annealing improved the fracture behavior of mild steels but had little effect on the high tensile steels; low temperature stress treatment had no noticeable effect on fracture strain; and, except for peened specimens, cracks were usually initiated from the inner surface of the tube specimen. (L.C.L.)

27049 (GEAP-5620) FAILURE BEHAVIOR IN ASTM A106B PIPES CONTAINING AXIAL THROUGH-WALL FLAWS. Reynolds, M. B. (General Electric Co., Pleasanton, Calif. Nucleonics Lab.). Apr. 1968. Contract AT(04-3)-189. 15p. Dep. CFSTI.

The pressure load limit for a cylindrical shell containing a flaw is a function of cylinder radius and wall thickness, flaw dimensions, and the properties of the material. The strength of large diameter thin-wall cylinders of brittle material containing axial through-wall flaws can be predicted by linear elastic fracture mechanics, by applying suitable corrections for the effects of curvature. For cylinders of more ductile material, it is necessary also to take into account the effect of plastic yielding at the tip of the advancing flaw. Relations between burst pressure, flaw size, and material properties used to predict the behavior of axially flawed cylinders for which the product of radius and wall thickness is 20 in.^{2} or greater were developed. Results of hydrostatic tests at 60°F on flawed ASTM A106B pipes in the diameter range of 4 to 12 inches are presented. Variation of limit pressure with flaw length and pipe dimensions is described for pipes having radius-wall thickness products as low as 0.5 in.^{2} Development of an empirical equation to predict behavior of small diameter, ductile pipes having axial through-wall flaws is discussed. (auth)

27050 (GEAP-5622) FAILURE DIAGRAM FOR AXIALLY FLAWED PIPES. Reynolds, M. B. (General Electric Co., Pleasanton, Calif. Nucleonics Lab.). Apr. 1968. Contract AT(04-3)-189. 9p. Dep. CFSTI.

The relationship between flaw configuration and the maximum pressure load which can be sustained by axially flawed pipes is discussed. Both axial through-wall flaws and part-through flaws are considered. A method of plotting burst strength versus flaw length data to produce a useful failure diagram is presented. (auth)

27051 (GECR-5401) EVALUATION OF FAILED 3-INCH TEE AT CONSUMERS BIG ROCK POINT PLANT. Higgins, J. P. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Jan. 1967. 25p. (67-APE-1).

A small leak was detected in a 3-inch tee of the Consumers Big Rock Point power plant piping system in May 1966. A post-operational examination revealed that the failure of the tee was a result of thermal fatigue. It is postulated that local thermal stress cycles caused by turbulence, plus larger thermal stresses caused by flow interruptions and variable line temperatures are responsible for the failure. The thermal sleeve used to protect the tee was inadequate for the service conditions. (auth)

27052 (N-69-10931) ABSORPTION RATE STICKING PROBABILITIES FOR OXYGEN ON COLUMBIUM AND DILUTE COLUMBIUM-ZIRCONIUM ALLOYS. Barrett, Charles A. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Nov. 1968. 41p. (NASA-TN-D-4885). CFSTI.

Sticking probabilities for oxygen on niobium and dilute niobium-zirconium alloys were derived from ratios of oxygen absorption rates to their corresponding oxygen fluxes. Oxygen test pressures were varied from 10^{-7} to 10^{-5} torr at 1158 to 1373°K. The absorption rates were derived from a pressure-drop technique and fluxes from constant pressure measurements. The kinetics of the reaction are discussed as well as characteristics of the test method. (auth) (STAR)

27053 (N-69-19200) EXPLORATORY STUDY OF MECHANICAL PROPERTIES AND HEAT TREATMENT OF MOLYBDENUM-HAFNIUM-CARBON ALLOYS. Raffo, Peter L. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Feb. 1969. 44p. (NASA-TN-D-5025). CFSTI.

A preliminary study was made of the structure and properties of Mo−Hf−C alloys. The compositions of the alloys ranged from 0.09 to 1.83 atomic percent Hf and 0.29 to 1.07 atomic percent C. The mechanical properties of these alloys were measured in the as-swaged, recrystallized, solution-treated, and aged conditions at room temperature and 1500 to 3000°F (1088 to 1922°K). The mechanical properties were compared with data on other molybdenum alloys in the literature, and two commercial molybdenum alloys that were evaluated during this program. The Mo−Hf−C alloys show a strength advantage over the other alloys in creep-rupture tests at 2400°F (1588°K) and short-time tensile tests at 3000°F (1922°K). (auth) (STAR)

27054 (ORNL-4369, pp 21-9) PROPERTIES OF 12-IN.-THICK ASTM A 533-B CLASS 1 AND CLASS 2 STEELS. Berggren, R. G.; Jones, T. N. (Oak Ridge National Lab., Tenn.).

Results of tensile tests are presented for specimens from heat 1195-1, HSST plate O2. (J.R.D.)

27055 (RD/B/N-1233) THE PREPARATION OF OXIDATION RESISTANT COATINGS FOR URANIUM. PART IV. INTERDIFFUSION IN THE SYSTEM U-Al/Mg-MAGNOX. Pearce, R. J.; Bull, D. J. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Feb. 1969. 26p. Dep. CFSTI. UK.

Studies of interdiffusion in the systems U−Al−Magnox and U−AlMg alloy−Magnox are described, and the feasibility of using these systems for preparing bonded and oxidation resistant coated fuel elements is discussed. The factors limiting this application are shown to be the problems of obtaining an adequately thick UAl_x layer to provide oxidation resistance and of not allowing the Al content in any residual Al−Mg alloy to exceed ~1 wt %. The data show that both of these conditions may be fulfilled by using a 9% Al−Mg alloy with a heat treatment time of ~90 h at 510°C. From current reactor experience this approach appears economically unattractive. (auth) (UK)

27056 (RT/MET-(69)1) BEHAVIOR OF URANIUM RICH ALLOYS ON THERMAL CYCLING. Fizzotti, C.; Masperoni, A. (Comitato Nazionale per l'Energie Nucleare, Rome (Italy)). 1969. 29p. (In Italian). Dep.

Investigations on thermal cycling behavior of binary and ternary uranium-rich alloys containing 0.5 to 3 wt % molybdenum, niobium, and zirconium are described. Additions of molybdenum and niobium to uranium were more effective in reducing surface wrinkling than additional zirconium. Surface wrinkling was influenced by the size and shape of the α grains produced in the alloys by different thermal treatments. (auth)

27057 (TRG-Report-1743) AN ELECTRON MICROSCOPE EXAMINATION OF THE ALPHA MANGANESE PRECIPITATE IN Mg-Mn CREEP SPECIMENS. Marsh, D. J. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). Aug. 14, 1968. 15p. Dep. CFSTI. UK 4s. 0d.

Electron microprobe and electron microscope examinations of the alpha manganese precipitate in a series of creep specimens, and thermally aged samples of Mg 0.7 to 1.5 wt % Mn alloys, are described. The precipitate forms in long thin laths and also as thick polygons. The lath form is favored at low temperatures, but both morphologies persist throughout the temperature range examined (350 to 560°C). Oriented zones denuded of precipitate during creep were also studied; no trace of precipitate was found up to the highest magnifications (× 100,000). No clear indications were found of the mechanism of origin of the denuded zones. (auth) (UK)

27058 (TRG-Report-1776) FRACTURE TOUGHNESS OF 0.36 PERCENT CARBON STEEL AS REVEALED BY THE INSTRUMENTED CHARPY IMPACT TEST. Terry, P. (United Kingdom Atomic Energy Authority, Culcheth (England). Reactor Group). Aug. 30, 1968. 19p. (JNPC(SSG)/P-(68)91). Dep. CFSTI. UK 3s.

It is shown that, using the instrumented Charpy impact machine, valid fracture toughness values can be obtained for a low-strength steel from fatigue cracked Charpy specimens. The results obtained compare very favorably with results available from other tests on the same material. (auth)

27059 A RESISTOMETRIC STUDY OF HYDRIDE PRECIPITATION IN ZIRCALOY-2. Sasaki, Yasuo; Kimura, Hirozo. Suiyokaishi, 16: 462-5(Oct. 1968). (In Japanese).

Two stages occur in hydride precipitation: the first stage corresponds to the growth of small plates; the second stage to the thickening of these plates. The activation energy obtained from isothermal data in both stages corresponds with that for the diffusion of hydrogen in α-Zr. 17 ref. (Metals Abstr.)

27060 REACTIONS OF NIOBIUM AND TANTALUM WITH GASES AT HIGH TEMPERATURES AND LOW PRESSURES. Fromm, E.; Jehn, H. (Max-Planck-Institut fuer Metallforschung, Stuttgart). Vacuum, 19: 191-7(Apr. 1969).

The gas-metal reactions of niobium and tantalum solid solutions with such gases as hydrogen, nitrogen, oxygen, water vapour, carbon monoxide, and methane at high temperatures and low pressures are briefly discussed. The equilibrium pressures and the conditions for steady states are presented. These data enable estimation of the gas content of niobium and tantalum after vacuum annealing processes, when the temperature of the specimen and the partial pressures of the gases are known. (auth)(UK)

27061 STUDY OF THE FATIGUE OF METALS UNDER VACUUM AND ULTRAVACUUM. Aubry, B.; Bernardet, H. Met. Constr. Mec., 100: 47-9; 51-3(Jan. 1968). (In French).

Fatigue tests were run on Al specimens under atmospheric conditions and in vacuums of less than 5×10^{-10} torr to study the effect of adsorbed O_2, N_2 and H_2 gas. Results show the relationship which exists between crack propagation and fatigue life as a function of O_2 pressure. The O_2 layer prevents rewelding of the cracks during compression and diminishes the binding energy between atoms on the metal surface. Because of the special form of the cracks and the frequency of vibratory movement, metallic surfaces behave under pressures of less than 10^{-4} torr as if they were under ultravacuum. A partial pressure of O_2 of less than 10^{-3} torr is sufficient to reduce the fatigue characteristics of Al. Analogous studies are underway on Cu. Results obtained, up to the present time, confirm those found for Al. (Metals Abstr.)

27062 ELECTROTRANSPORT OF CARBON, NITROGEN, AND OXYGEN IN LUTETIUM. Peterson, D. T.; Schmidt, F. A. (Ames Lab., Iowa). J. Less-Common Metals, 18: 111-16(June 1969).

The electrotransport velocities of carbon, nitrogen and oxygen in lutetium were measured at 1330, 1450 and 1600°C. All three solutes migrated in the same direction as the electron flow. Diffusion coefficients and effective charges were calculated for these elements at the same temperatures. Electrotransport was shown to be an effective method of purifying lutetium as indicated by resistance ratio measurements. (auth)

27063 THERMAL EXPANSION BEHAVIOR OF $YbZn_2$ AND OTHER KHg_2-TYPE INTERMETALLIC COMPOUNDS. Michel, D. J.; Ryba, E. (Pennsylvania State Univ., University Park). J. Less-Common Metals, 18: 159-65(June 1969). (NYO-3560-15).

The thermal expansion coefficients of $YbZn_2$, from high temperature x-ray diffraction studies, were found to be (25 to 305°C). $\alpha_a = 1.56 \times 10^{-5}/°C$, $\alpha_b = 1.90 \times 10^{-5}/°C$, $\alpha_c = 2.78 \times 10^{-5}/°C$. These results are similar to those previously obtained for $HoZn_2$. A structural interpretation of the thermal expansion behavior of these compounds is presented. Crystallographic evidence for a phase transformation in $YbZn_2$ is also given. (auth)

27064 EFFECT OF COLD WORKING, DURATION, AND TEMPERATURE OF ANNEALING ON Zr-2.5 PERCENT Nb ALLOY THERMAL EXPANSION. Lupakov, I. S.; Kuz'michev, Yu. S.; Rodchenkov, B. S. At. Energ. (USSR), 26: 236-9(Mar. 1969). (In Russian).

The effect of cold reduction (30 to 50%) and of duration (3 to 14 hours) and temperature (400 to 560°C) of subsequent annealing on the thermal expansion of Zr-2.5% Nb alloy has been studied. Cold reduction of Zr-2.5% Nb alloy annealed in $(\alpha + \beta)$-phase results in thermal expansion decrease. The reproduction of thermal expansion coefficient of Zr-2.5% Nb alloy exposed to cold working is observed after α-annealing. Nb redistribution in α-Zr solid solution changes the true thermal expansion coefficient of Zr-2.5% Nb alloy cold-worked and α-annealed with an increase in temperature. (auth)

27065 REVERSION PHENOMENA IN Cu-Zr-Cr ALLOYS. Suzuki, Hisashi; Kitano, Hitoshi; Kanno, Motohiro (Tokyo Univ.). Nippon Kinzoku Gakkaishi, 33: 334-8(1969). (In Japanese).

Reversion phenomena in aged Cu-0.12% Zr-0.28% Cr alloy were investigated by means of resistivity measurement and transmission electron microscopy, comparing with those of Cu-0.30% Zr and Cu-0.26% Cr alloys. Specimens in the form of a 0.5 mm sheet were solution-treated at 950°C for 1 hr, water-quenched, aged and finally reversed. The reversion phenomena were confirmed to exist in Cu-Zr and Cu-Zr-Cr alloys as well as Cu-Cr alloys, at aging temperatures between 300 and 500°C. The critical aging temperature for the reversion was not observed in all the alloys. The reversion behavior was commonly observed in each alloy: the greater the difference between aging and reversion temperatures, the larger the amount of reversion and the shorter the time to reach the maximum amount of reversion. Split aging increased the amount of reversion particularly in Cu-Zr and Cu-Zr-Cr alloys, compared with that by conventional aging. The amount of reversion in Cu-Zr-Cr alloy was greatly affected by the resolution of Cr precipitate formed by pre-aging. Structural changes in Cu-Zr-Cr alloy due to the reversion were barely observed by transmission electron microscopy. The above results should be explained on the assumption that the size of the precipitate is below the critical size for growth at the reversion temperature. (auth)

27066 QUANTITATIVE MICROPROBE ANALYSIS BY MEANS OF TARGET CURRENT MEASUREMENTS. Colby, J. W. (National Lead Co. of Ohio, Cincinnati); Wise, W. N.; Conley, D. K. Contract AT(30-1)-1156. Advan. X-Ray Anal., 10: 447-61(1967).

From 15th Annual Conference on Applications of X-Ray Analysis, Denver, Colo. See CONF-660814.

In the microprobe analyzer, a portion of the high-energy electrons impinging on the surface are backscattered from the sample and re-emitted at high energy levels. Low-energy (less than 50 eV) or secondary electrons also are emitted. Both the electron backscatter yield and the secondary electron yield are related to the mean atomic number of the target material and, hence, may be used to provide information about the target composition. Unfortunately, however, the secondary electron yield is very sensitive to the surface condition of the specimen and various instrument parameters. This complicates the otherwise simple linear relationship between sample composition and electron backscatter yield. It is shown that the effects due to secondary electrons can be minimized by biasing the sample, and that good results can be obtained in the analysis of binary systems. The limitations and utility of the method are discussed, and backscatter yields are determined. (auth)

27067 THERMOMIGRATION AND ELECTROMIGRATION IN ZIRCONIUM. Campbell, D. R.; Huntington, H. B. (Rensselaer Polytechnic Inst., Troy, N. Y.). Phys. Rev., 179: 601-12 (Mar. 15, 1969).

Experiments on directed atom motions in β-Zr have been carried out with a view to bringing additional experimental evidence to bear on the current conflicting theories of the anomalous diffusion behavior in this and other bcc refractory metals. Thermomigration and electromigration effects have been studied primarily by the surface marker technique in zirconium wires (purity 99.9%) and rods (purity 99.98%). The thermomigration effects were large, with the mass flow to the hot (central) region of the specimens. The effective activation energy for this flow was 26 ± 3 and 29 ± 3 kcal/mole for wires and rods, respectively. These values are quite close to the activation energy for the so-called "low-temperature diffusion mechanism" ($Q = 27.7$ kcal/mole) obtained from tracer diffusion data. If one assumes that this is the operative mechanism, then Q^*/f turns out to be -34 ± 11 kcal/mole. The fact that the forced motion shows no evidence of a high-temperature mechanism lends support to the hypothesis that this motion is primarily by dislocation, or short-circuit paths. The electromigration, on the other hand, is a very small effect for this material, with motion apparently toward the cathode. The activation energy is in the neighborhood of 30 kcal/mole, and the effective charge Z^*/f is about +0.3. (auth)

27068 COBALT SUPERALLOYS. III. IN-PROCESS METALLURGY OF WROUGHT COBALT-BASE ALLOYS. Herchenroeder, R. B.; Ebihara, W. T. (Union Carbide Corp., Kokomo, Ind.). Metals Eng. Quart., 9: No. 2, 30-41(May 1969).

The metallurgy and properties of Haynes Alloys No. 6B, No. 25, and No. 188 are reviewed. Cold working characteristics, recrystallization behavior and precipitation phenomena during recrystallization heat treatments are emphasized. (J.R.D.)

27069 THE COMPLEX IMPREGNATION OF IRON WITH BERYLLIUM, MANGANESE, AND BORON [AND THE RESISTANCE OF THE COATED MATERIAL TO FUSED ALUMINUM]. Mel'nik, P. I. Izv. Vyssh. Ucheb. Zaved., Chern. Met., No. 8, 135-8(1968). (In Russian).

Using the pack method, Fe specimens were diffusion-impregnated at various temperatures and exposure times successively and simultaneously with pairs of elements: Mn-Be, Be-Mn, Be-B, B-Be, Mn-B and B-Mn. The resistance of the coated iron to fused Al was examined. With complex diffusion-impregnation it is possible to obtain layers of Be and Mn borides, and of Mn beryllides. A layer of B beryllide does not break down in fused Al at 900°C. (Metals Abstr.)

27070 INFLUENCE OF RARE ELEMENTS ON THE CRYSTALLIZATION OF THE ALLOY Al10V. Parkhutik, P. A.; Lubenskii, M. Z. Lietinoe Proizvod., No. 2, 43-4(Feb. 1968). (In Russian).

The influence of additions of 0.02 to 1.0% each of Ti, Zr, and Ce on the crystallization of the Al-base A110V alloy, containing Cu 6, Si 5, Mg 0.4, and Fe 1.2% was examined by the construction of cooling curves. In the uninoculated alloy primary crystallization of α solid solution commences at 602°C. The addition of 0.1% Ti or Zr raises this temperature to 606°C, and with 1.0% Ti to 612°C. Up to 1.0% Ce has no influence on primary crystallization. Secondary crystallization of Si commences at 545 to 550°C, and is uninfluenced by the presence of inoculants. Ce is practically insoluble in solid Al. (Metals Abstr.)

27071 MECHANICAL AND THERMAL BEHAVIOUR OF SINTERED TUNGSTEN-SILVER MATERIALS. Heymann, G.; Prietzel, K.-O. Wiss. Z. Tech. Hochsch. Otto Guericke Magdeburg, 11: 673-5(1967). (In German).

Six materials were examined metallographically and their moduli of elasticity and thermal coefficient of expansion at 20 to 500°C determined. The material with the composition W 74, Ag 25, and Ni 1% exhibited the highest modulus of elasticity (both tensile and compressive) and the lowest coefficient of thermal expansion. (Metals Abstr.)

27072 ELASTIC MODULI AND ULTRASONIC ATTENUATION OF PRASEODYMIUM, NEODYMIUM, AND SAMARIUM FROM 4.2 TO 300^{0}K. Rosen, M. (Nuclear Research Center, Beer Sheva, Israel). Phys. Rev., 180: 540-4(Apr. 10, 1969).

The LA and TA wave velocities and the ultrasonic attenuations of high-purity polycrystalline Pr, Nd, and Sm were measured by a pulse technique at a frequency of 10 MHz between 4.2 and 300°K. The temperature variation of the Young moduli E, shear moduli G, adiabatic compressibilities K_s, Debye temperatures Θ_D, and ultrasonic attenuations were determined. The anomalies in the elastic and anelastic properties, observed at temperatures below 25°K, were correlated with the antiferromagnetic transitions known to occur in these metals. The elastic moduli of Nd behave in a normal manner between room temperature and its Néel point (18°K). In contrast, Pr and Sm display maxima at 78 and 109°K, respectively, followed by a sharp decrease in the elastic moduli with decreasing temperature, i.e., the appearance of a lattice-softening phenomenon. Noteworthy is the similarity in the temperature variation of the elastic moduli and ultrasonic attenuations between Pr and Sm. The anomalies at 78 and 109°K, in these metals, are believed to be due to an electron-type transition or to a crystallographic phase change rather than to an antiferromagnetic ordering. (auth)

27073 THERMAL CONDUCTIVITIES AND LORENZ FUNCTIONS OF GADOLINIUM, TERBIUM, AND HOLMIUM SINGLE CRYSTALS. Nellis, W. J.; Legvold, S. (Ames Lab., Iowa). Phys. Rev., 180: 581-90(Apr. 10, 1969).

The thermal conductivities of gadolinium, terbium, and holmium single crystals were measured as a function of temperature from 5 to 300°K. The steady-state heat-flow method was used. For each element measurements were taken in the $\langle 11\bar{2}0\rangle$ (a-axis) and in the $\langle 0001\rangle$ (c-axis) directions of the hexagonal close-packed crystal structure. Electrical resistivity measurements were made on the same samples to obtain Lorenz functions. Anomalies near magnetic transition temperatures are interpreted in terms of magnetic superzones and spin-disorder scattering. High-temperature anisotropy is interpreted in terms of Fermi-surface anisotropy. Lorenz numbers appreciably larger than L_0 suggest that phonons and magnons, in addition to electrons, can carry heat. (auth)

27074 EFFECT OF ALLOYING ELEMENTS ON THE DIFFUSION MOBILITY OF MOLYBDENUM, MANGANESE, AND SILICON. Krishtal, M. A.; Mokrova, A. M. Uch. Zap. Tul'sk. Gos. Pedagog. Inst. Fiz.-Tekh. Nauk, No. 1, 93-100(1967). (In Russian).

A study of the effect of single and multi-component alloying on the diffusion mobility of Mo, Si, and Mn in Fe at 1050 to 1290°C was made. The activation energy (Q) for the diffusion of Mn, Mo, and Si from a binary alloy into Fe is less than Q in more complex alloy systems. The alloying of Fe with Cr, Mn, Ti, and Mo causes a change in Q from 49 to 61 kcal/mole. Complex multi-alloying does not always lead to retardation of diffusion processes: the level of diffusion mobility of Mo at temperatures above 1200°C is larger in Fe alloyed with Cr, Ti, and Mn than in unalloyed Fe. Multi-component alloying does not always cause an increase in oxidation resistance at high temperature. Values are given for the diffusion coefficient, the pre-exponential factor D_Q, and the change in the entropy of diffusion, ΔS, for the various diffusion conditions studied. (Referativnyi Zh.)

27075 THE EFFECT OF SMALL OXYGEN ADDITIONS ON THE ELASTIC CONSTANTS AND LOW TEMPERATURE ULTRASONIC ATTENUATION OF Nb SINGLE CRYSTALS. Jones, K. A. (3M Research Center, St. Paul); Moss, S. C.; Rose, R. M. Acta Met., 17: 365-72(Apr. 1969).

Elastic constants and ultrasonic attenuation of pure Nb single crystals and single crystals doped with oxygen were measured by the pulse superposition technique at 4.2 to 313°K. The principal effects of the added oxygen were to decrease slightly all constants but C' and C_{44}, the two $\langle 110\rangle$ shear constants, and also to bring about the appearance of a secondary dip in the attenuation at temperatures below the superconducting transition. No discontinuities in the elastic constants were observed, so it was concluded that spontaneous ordering of oxygen in Nb did not occur in this case. The substructure responsible for the extra dip in the attenuation below T_c is therefore due to other causes, the most likely of which is oxygen clustering above room temperature. This hypothesis is supported by a variety of other data. (auth)

27076 ROLE OF NIOBIUM IN THE IMPROVEMENT OF THE MECHANICAL PROPERTIES OF WELDABLE CONSTRUCTION STEELS. III. Mandry, Pierre. Metaux (Corros.-Ind.), 43: 24-48(Jan. 1968). (In French).

Results presented previously are analyzed and interpreted. The effect of Nb on the characteristics of the principal structures and the effect of the austenitization temperature are discussed. The formation of precipitates is described. The effect of niobium on the stability of the austenite, ferrite, and martensite phases is considered. (J.S.R.)

27077 X-RAY DEBYE TEMPERATURE OF TUNGSTEN. Walford, L. K. (Southern Illinois Univ., Edwardsville). Mater. Res. Bull., 4: 137-42(Feb. 1969).

The x-ray Debye temperature (Θ^M) of tungsten has been measured to be 377 ± 11°K. The method used was the measurement of the integrated intensity of the $\{310\}$ and $\{321\}$ reflections at two temperatures. (auth)

27078 OXIDATION OF Be-Ca ALLOYS IN CO_2 AT HIGH TEMPERATURES. Nishigaki, Susumu; Kondo, Yasuko (NGK Insulators Ltd., Nagoya, Japan). Nippon Kinzoku Gakkaishi, 33: 455-60(Apr. 1969). (In Japanese).

Three Be-Ca alloys with varied Ca contents were oxidized at 600 to 700°C. A kinetic analysis of the rates of weight gains at different temperatures led to a conclusion that the oxidation proceeded through at least three stages. A close relation was noted between the mode of the oxide film growth and the oxidation behavior at each stage. Addition of a small amount of Ca improved the corrosion-resistance of Be. The effect was explained in terms of dispersion of the corrosion resistant $Be_{13}Ca$ phase, and formation of a Ca-rich layer at the metal-oxide interface which plays a vital role as a barrier against Be-ion diffusion. (NSA of Japan)

27079 INVESTIGATION OF THE IMPREGNATION OR SOAKING KINETICS OF METALLOCERAMIC BODIES. Borok, B. A.; Golikov, I. N.; Goryaev, G. A.; Dzneladze, Zh. I.; Kunin, L. L.; Lobashev, B. P. Fiz. Khim. Obrab. Mater., No. 2, 101-10(1968). (In Russian).

The soaking kinetics of porous tungsten in water, toluene, butanol, and ethanol was studied as a function of the nature of the liquid phase, degree of porosity of solid phase, temperature, and ambient pressure. The experiments were carried out in search of the basic mechanism involved in the production of pseudo-alloys by impregnating metal ceramic materials with liquid metals. The experiments were performed on cylindrical specimens (100 mm high and 35 mm diameter) of various porosities controlled by regulating the sintering period of the specimens. The specimens were suspended above the liquid under investigation, contained in a double-walled thermostated cylindrical vessel in such a manner that the specimen just touched the level of the liquid. The degree of liquid absorption was checked periodically by determining the increase in mass of the metal specimens. It was found that, for each liquid studied, the degree of absorption reached a saturation limit, the magnitude of which increased with decrease in the ambient pressure and depended on the nature of the liquid, temperature, and degree of porosity of the metal specimen. It was further found that the rate of liquid absorption K obeyed the equation: $h^2 = K\tau$, where h is the height of liquid rise in the metal specimen and τ is the time, directly proportional to the porosity of the metal specimens. (JPRS)

27080 SOLUBILITY OF NITROGEN IN LIQUID NIOBIUM AND MOLYBDENUM. Kozina, L. N.; Rebyakin, A. V.; Samarin, A. M. Dokl. Akad. Nauk SSSR, 184: 397-9(Jan. 11, 1969). (In Russian).

The solubility curve of nitrogen in liquid niobium determined within the partial pressure range from 0.1 to 0.1 atm, revealed a marked positive deviation from Henry's law; the equilibrium constant K_e was found to depend on the nitrogen concentration in the niobium. After melting in an electron-beam furnace, the nitrogen content of the niobium was reduced to 0.01 to 0.03%; the partial pressure of nitrogen in equilibrium at that concentration was found to lie between 5.5×10^{-4} and 5.0×10^{-3} mm of Hg; however, the actual nitrogen content was higher than the equilibrium value. The results of the study of the solubility of nitrogen in liquid molybdenum revealed an unusual relationship between the nitrogen content and its partial pressure. The molybdenum melted in an electron-beam or arc furnace was found to contain about 0.001% nitrogen, with a corresponding partial pressure of 3.3×10^{-3} mm of Hg. Thus as in the previous case, the nitrogen was not in equilibrium with the gas phase and its libration is not limited by thermodynamic factors. (TTT)

27081 PROTECTION OF ZIRCONIUM ALLOY COMPONENTS AGAINST HYDRIDING. Sawatzky, A. (to Atomic Energy of Canada Ltd.). Canadian Patent 805,850. Feb. 4, 1969.

A Zr alloy pressure tube has a number of "sacrificial" fins bonded to it. These fins are joined by a hydrogen pervious bond and preferentially absorb hydrogen in service so that the tube does not become embrittled. The fins are in the space between the calandria tube and the pressure tube with a temperature gradient along the fins of the 10°C/cm. Hydrogen, which may be absorbed by the pressure tube, diffuses to the fins because they can be maintained at a lower temperature. Significant protection from hydriding results. (F.S.A.)

27082 HARDENING NIOBIUM ALLOYS BY THERMAL TREATMENT. Eliseev, S. A.; Shpitsberg, A. L.; Ryabysheva, N. D. Tsvetn. Metal., No. 12, 72-4(Dec. 1968). (In Russian).

It is shown that tempering from temperatures of the order of 1800 to 1900°C leads to a significant increase in hardness, which is increased in the series of alloys by subsequent aging. The process of hardening after tempering was noted in tests of hot hardness of alloys up to 1000°C. (tr-auth)

27083 A MASS SPECTROMETRIC INVESTIGATION OF THE HIGH-TEMPERATURE DIFFUSION OF URANIUM IN TUNGSTEN AND THE ALLOTROPIC PHASE TRANSITION IN ZIRCONIUM. Schwegler, E. C. Jr.; White, F. A. (Rensselaer Polytechnic Inst., Troy, N. Y.). J. Mass Spectrom. Ion Phys., 1: 191-208(June 1968).

The diffusion rates of uranium in tungsten between 1970 and 2730°C were measured using a mass spectrometric technique. In this temperature range the diffusion coefficient of uranium in tungsten followed the relation $D = (1.80 \pm 1.05) \times 10^{-2} \exp(-93.0 \pm 6.0 \text{ kcal mole}^{-1}/RT)$. The mass spectrometer was also used to detect the allotropic phase change in zirconium by measuring the change in activation energy for the diffusion of rubidium in zirconium over the temperature range between 760 and 1030°C. To measure the diffusion coefficients, thin ribbons of the solvent metals, each of which contained a low concentration of solute material as an impurity, were used as high-temperature thermal ion sources in a mass spectrometer. The mass spectrometer was utilized to detect the time variation of the solute ion beams from these ribbons for various temperatures. From these data the desired diffusion coefficients were calculated using the Fick's law solution for impurity evaporation from a thin plate. The activation energies were found from plots of the natural logarithm of the diffusion coefficients versus inverse temperature. (auth)

27084 WROUGHT MAGNESIUM-BASE ALLOY. Blyablin, A. A.; Mishkin, V. L.; Yemel'yanova, O. V.; Timonova, M. A.; Kutaytseva, A. L.; Strokova, N. P.; Batyunya, N. G.; Kabanova, T. S. Russian Patent 223,355. (In Russian).

A wrought magnesium-base alloy containing in wt. % 5 to 7 Zn, 0.1 to 2.0 Cd, 0.4 to 1.0 Zr, with 1.4 to 3.0 Nd added to improve the physicomechanical properties of the alloy is described. (JPRS)

27085 COMPOSITION, STRUCTURE, AND PROPERTIES OF CAST MOLYBDENUM ALLOYS OBTAINED BY VARIOUS MELTING METHODS. Belous, O. A. Fiz. Khim. Obrab. Mater., No. 6, 84-91(1968). (In Russian).

The effect of chemical composition and melting conditions on the structure and mechanical properties of Mo alloys was studied with a view to reducing the tendency of these towards brittle failure. Two possible ways of reducing the temperature at which cast Mo alloys passed into the brittle state were discovered. One of these was based on the combination of interstitial impurities with Y, La, and Ti to reduce them to inactive form. The other was based on alloying with Fe, which increased the ductility of the Mo by displacing the most active embrittling impurities from the grain boundaries. (Metals Abstr.)

27086 PLASTIC DEFORMATION OF REFRACTORY METALS IN VACUUM. Gurevich, Ya. B.; Orzhekhovskii, V. L. Sb. Tr. Tsent. Nauch-Issled. Inst. Chern. Met., No. 58, 198-211(1968). (In Russian).

A study was made of the high-temperature plastic deformation of the refractory metals Mo, W, Ti, and Nb in a vacuum of 10^{-4} to 10^{-5} torr. This process differs from that in air because of the absence of surface oxides and this results in an increase in external friction and resistance to deformation (specific pressure) for Mo and W and a reduction in these effects with Ti and Nb. Hot deformation in a high vacuum retains the initial content of active gases (somewhat decreased in W), increases the grain size, gives a uniform structure, raises the ductility, and lowers the critical brittle temperatures. The effect of an inert gas atmosphere on the features and effects of the hot deformation of refractory metals is similar to that of a vacuum of 10^{-2} to 10^{-3} torr. 43 references. (Metals Abstr.)

27087 CIRCUMFERENTIAL DUCTILITY OF FUEL CLADDING TUBES. Okubo, Tadatsune; Tanabe, Tatsuhiko (Tokyo Univ.). Tokyo Daigaku Kogakubu Kiyo, A, No. 6, 66-7(Dec. 1968). (In Japanese).

The main characteristic necessary for zircaloy fuel cladding tube is the ability to accommodate circumferential strains resulting from the diametrical expansion of fuel pellet. Testing methods of measuring the circumferential ductility of the tubes are described. Effects of zirconium hydride platelets on the ductility are discussed. (auth)

27088 WROUGHT MOLYBDENUM-BASE ALLOY. Solov'ev, V. Ya.; Mal'tsev, M. V.; Movchan, B. A.; Osokin, N. G.; Shchukin, A. A.; Danilovtseva, O. G.; Kozlova, N. A.; Demkina, S. B.; Khachaturov, A. A. Russian Patent 223,356. (In Russian).

A wrought molybdenum-base alloy containing 0.08 to 0.10% carbon is described. To enhance the physicomechanical and technological properties of the alloy, 0.08 to 0.12% iridium is added to the composition. (JPRS)

27089 THE MECHANISM OF VOID GROWTH AND FACTORS AFFECTING THE ONSET OF INTERGRANULAR FAILURE DURING CREEP OF A Mg-0.8 PERCENT Al ALLOY. Evans, H. E. (Central Electricity Generating Board, Berkeley, Eng.). Metal Sci. J., 3: 33-8(Jan. 1969).

Tensile tests on a Mg-0.8% Al alloy were conducted at a strain rate of 10^{-2} h^{-1} between 25 and 400°C with grain sizes ranging from 0.009 to 0.300 in. It is shown that the growth of voids occurs by a grain-boundary sliding mechanism and the variation of ductility in the intergranular-failure range is interpreted by means of this parameter. The factors that lead to the onset of intergranular failure are discussed in terms of the relative ease of nucleation and rate of growth of intragranular cracks and grain-boundary cavities. (auth) (UK)

27090 TECHNIQUES FOR ENHANCING MECHANICAL VALUES OF STEELS FOR NUCLEAR-REACTOR PRESSURE VESSELS. Bohusova, Olga; Mazanec, Karel. Hutn. Listy, 23: 875-9(Dec. 1968). (In Czech).

Laboratory and technical trials of (200-mm) thick plates for nuclear-reactor pressure vessels showed that the mechanical properties of the plates could be enhanced by grain refinement. This effect was achieved by the addition of Nb, which enhances mechanical values and keeps them uniform through the thickness of the plate; a low notch-toughness transition temperature is also maintained. By heat treatment the mechanical values were considerably enhanced at the operating temperature (250°C). 14 references. (Metals Abstr.)

27091 HIGH TEMPERATURE REFRACTORY METALS, NEW YORK, FEBRUARY 16-20, 1964. PART 2. Fountain, R. W.; Maltz, Joseph; Richardson, L. S. (eds.). Metallurgical Society Conferences, Volume 34. New York, Gordon and Breach Science Publishers, Inc., 1966. 480p. (CONF-524-(Pt. 2)).

Twenty-four papers were presented at the conference. A separate abstract was prepared for each of twenty-two papers. Papers for which no abstracts were prepared are concerned with chromium oxides and transition temperatures in bcc metals. (J.R.D.)

For abstracts of individual papers see: 26434, 27041–27043, 27092–27106, 27120, 27121, and 27161.

27092 BERYLLIUM TECHNOLOGY. Duletsky, Paul S. (Air Force Materials Lab., Wright-Patterson Air Force Base, Ohio). Met. Soc. Conf., 34: 1-22(1966).

From Conference on High Temperature Refractory Metals, New York. See CONF-524-(Pt. 2).

The current beryllium structural component developments for missile, aerospace, and jet engine applications are examined. The effect of low order deformation on mechanical properties is discussed. The need to reduce the impurity levels in commercial beryllium powder is presented with relation to increasing reliability and reproducibility, and eliminating extraneous variables. A comparison of the mechanical properties in extruded flats of ultra-high purity (vacuum distilled and zone refined) and commercial grade beryllium is made. Variations in grain size and percent recrystallization exist in the extruded specimens; however, a general correlation between purity, grain size, and strength appears to be evident. Initial ballistic impact testing of I-400 type beryllium for jet engine compressor blade application is discussed. Data on structural component developments by aircraft and missile manufacturers reflect the current state of the art in the utilization of beryllium sheet. (auth)

27093 RHENIUM AND RHENIUM ALLOY TECHNOLOGY. Port, John H. (Chase Brass and Copper Co., Inc., Waterbury, Conn.). Met. Soc. Conf., 34: 23-43(1966).

From Conference on High Temperature Refractory Metals, New York. See CONF-524-(Pt. 2).

The development of Re and Re alloy technology is reviewed from the time of discovery of Re in 1925 to the present. Included are discussions of sources and production of Re; the electric, mechanical, and physical properties of Re; the effects of Re as an alloying additive to Mo and W; methods using powder metallurgy for fabricating Re and Re alloys; and the uses and costs of Re, Mo–Re, and Re–W alloys. (L.C.L.)

27094 TENSILE PROPERTIES OF CHROMIUM AND CHROMIUM–RHENIUM ALLOYS. Gilbert, A.; Reid, C. N.; Hahn, G. T. (Battelle Memorial Inst., Columbus, Ohio). Contract NASW-101, HS-180. Met. Soc. Conf., 34: 194-214(1966).

From Conference on High Temperature Refractory Metals, New York. See CONF-524-(Pt. 2).

Tensile tests were made on recrystallized iodide chromium, Cr-1 at. % Re, and Cr-35 at. % Re over the temperature range −196 to 700°C. The pure Cr proved brittle at temperatures below 30°C, whereas the high Re alloy retained some ductility down to −196°C, deforming by both slip and twinning prior to failure. The high Re alloy also exhibited marked and unusual dynamic strain-aging behavior, suggesting that Re alloying increases interstitial solubility from 300 to 600°C. The yield and flow data on pure Cr over the same temperature range indicated that interaction of dislocations with precipitates was the main source of strengthening rather than the classical picture of an interstitial drag on moving dislocations. (auth)

27095 RECENT STUDIES ON THE COLUMBIUM–1 PERCENT ZIRCONIUM ALLOY. Thurber, W. C.; Distefano, J. R.; Kollie, T. G.; Inouye, H.; McCoy, H. E.; Stephenson, R. L. (Oak Ridge National Lab., Tenn.). Met. Soc. Conf., 34: 59-77(1966).

From Conference on High Temperature Refractory Metals, New York. See CONF-524-(Pt. 2).

Work on creep behavior, emittance measurements, contamination in vacua, compatibility with lithium, and internal friction of Nb–Zr alloys is summarized. Measurements of the tensile creep and rupture behavior in vacuum at temperatures of 982 and 1204°C have been conducted. Test data obtained indicate that the creep properties parallel and transverse to the rolling direction are comparable. The total hemispherical emittance of this alloy has been measured at 100 to 1200°C at pressures of 10^{-6} torr. The emittance values above 600°C are affected by specimen oxidation even at these low pressures. The contamination by interstitial elements of Nb-1% Zr in high vacua (approximately 10^{-7} torr) has been systematically studied as a function of such variables as temperature, specimen thickness, and protective wrapping. Results indicated that Nb-1% Zr is much more sensitive to contamination than are unalloyed niobium, molybdenum, or tantalum and that low-pressure nitrogen is not effective in reducing contamination. The feasibility of using a gas addition to poison the alloy surface and thereby decrease the number of adsorption sites available to the contaminating species has also been examined. Internal friction is being employed as a tool to study aging reactions in this alloy. In addition to affirmation of Nb–O and Nb–N peaks at 160 and 300°C, respectively, a peak attributed to Zr–O interaction has been detected at 220°C and peaks attributed to Zr–N interactions were identified at 380 and 480°C in Nb–Zr alloys. Compatibility studies of Nb–Zr alloys in lithium at 800°C have demonstrated that the addition of 1% Zr is sufficient to prevent attack of oxygen-contaminated alloys by lithium even with oxygen contents as high as 3300 ppM. Under comparable conditions, unalloyed Nb would have suffered severe intergranular penetration. (auth)

27096 FRACTURE TOUGHNESS OF REFRACTORY METALS AND ALLOYS. Marschall, C. W.; Holden, F. C. (Battelle Memorial Inst., Columbus, Ohio). Contracts AF33(616)-7604; AF33(657)-10363. Met. Soc. Conf., 34: 129-59(1966).

From Conference on High Temperature Refractory Metals, New York. See CONF-524-(Pt. 2).

Fracture toughness and notch strength of four refractory metals (Mo, W, Ta, Nb) and two alloys (TZM, D43) were investigated. Sheet-tensile specimens containing sharp central notches and fatigue cracks were tested at temperatures in the vicinity of the ductile-brittle transition. For the unalloyed metals, the variables studied included metallurgical structure (wrought versus recrystallized) and specimen orientation (Mo only). For the two alloys, the effects of 1-mil silicide coatings on fracture toughness and notch strength were evaluated for specimens with various sequences of coating, cracking, and simulated-service exposure. Notch strength and fracture toughness are lowered for W, Mo, and Nb, as the temperature is decreased; Ta remains ductile to at least −253°C in the presence of long fatigue cracks. The 1-mil silicide coating increased the transition temperature only slightly for TZM alloy, and not at all for the D43 alloy. (auth)

27097 STRAIN AGING EFFECTS IN TUNGSTEN DUE TO CARBON. Stephens, Joseph R.; Form, G. Willy (Lewis Research Center, Cleveland, Ohio). Met. Soc. Conf., 34: 173-93 (1966).

From Conference on High Temperature Refractory Metals, New York. See CONF-524-(Pt. 2).

Strain aging characteristics of tungsten containing 8 and 40 ppM carbon were determined. Completely recrystallized tensile specimens were prestrained various amounts to 700°F and aged at 1200, 1500, and 1800°F for times up to 4 hours. Results show that dislocation locking by solute atoms was weak for the lower carbon level as evidenced by the lack of a yield drop in either the prestrained or aged condition. Specimens containing 40 ppM carbon exhibited a yield drop during the prestrain test. Aging for as much as 120 minutes at 1200°F did not result in a return of the yield drop. The change in yield strength was negative for short aging times at 1200°F but increased to a positive value after aging for longer times. Aging at 1500 and 1800°F resulted in a return of the yield drop, and the change in yield strength was positive for all aging times. Explanations of these phenomena are proposed. (auth)

27098 EFFECT OF TEMPERATURE AND STRAIN RATE ON THE YIELD AND FLOW STRESSES OF NIOBIUM. Conrad, H.; Stone, G. A. (Aerospace Corp., El Segundo, Calif.). Met. Soc. Conf., 34: 215-35(1966).

From Conference on High Temperature Refractory Metals, New York. See CONF-524-(Pt. 2).

The activation energy H, the activation volume v^* and the frequency factor v for the plastic deformation of niobium at low temperatures ($T < 0.25T_m$) were determined from the effect of temperature and strain rate on the yield and flow stresses. The values of H and v^* decreased from 0.75 eV and $55b^3$, respectively, at $\tau^* = 1$ kg mm^2; to 0.15 eV and $6b^3$, respectively, at $\tau^* = 30$ kg/mm^2. The value of v was 10^8 sec^{-1}. The results support the idea that thermally activated overcoming of the Peierls–Nabarro stress is rate-controlling during the deformation of the bcc metals at low temperatures. The values of the Peierls–Nabarro stress and energy, and the kink energy and kink width derived from the present results using Seeger's theory for the nucleation of kinks are $1.5 \times 10^{-2}\mu$, $6 \times 10^{-3}\mu\, b^3$, $6 \times 10^{-2}\mu\, b^3$, and 8b, respectively, in agreement with previously derived values. (auth)

27099 CHROMIUM ALLOY DEVELOPMENT IN AUSTRALIA. Wain, H. L.; Johnstone, S. T. M. (Aeronautical Research Labs., Melbourne). Met. Soc. Conf., 34: 286-308(1966).

From Conference on High Temperature Refractory Metals, New York. See CONF-524-(Pt. 2).

Development of a chromium-base alloy to give a combination of high-temperature strength, room-temperature ductility, and oxidation resistance are discussed. Data are presented on 2Ta–0.1Ti–0.5Si (Alloy E) creep, tensile, oxidation, and thermal shock properties. Attempts to improve the creep properties of Alloy E by further solid solution alloying and by strengthening the grain boundaries are described. The problem of retaining room-temperature ductility after exposure to air at high temperatures was studied. Some success was achieved by the addition of rare earth elements. Production of chromium alloys by arc melting, extrusion, swaging, and rolling is described briefly. Fabrication of chromium alloy turbosupercharger blades, and their successful operation, indicates the potential of these materials for eventual gas turbine application. (auth)

27100 TANTALUM BASE ALLOYS WITH HIGH STRENGTH ABOVE 3000°F. Amra, L. H.; Oxx, G. D. Jr. (General Electric Co., Cleveland). Met. Soc. Conf., 34: 309-25(1966).

From Conference on High Temperature Refractory Metals, New York. See CONF-524-(Pt. 2).

Alloys containing additions of elements for the purpose of solid solution and precipitation hardening were triple electron beam melted and processed to sheet. Twenty-five compositions, including additions of W, Re, Mo, Nb, Hf, Zr, V and C, were investigated. A series of ingots, weighing 4.4 pounds and in some cases 44 pounds, were extruded to sheet bar and warm rolled to sheet less than 0.100 in. thick. Ease of fabrication, tensile strength and ductility in the range of −320 to 3550°F were determined as a function of alloying additions. Some of the alloys after welding exhibited ductility at room temperature in a 2t bend test. Results showed that solid solution additions of rhenium and tungsten in combination had the most potent effect on 3550°F strength. Substitution of as little as one percent rhenium for one percent tungsten in the basic Ta-10W alloy raised the 3550°F strength by 50 percent. A Ta-10W-5Re alloy had an ultimate tensile strength of 19,400 psi at 3550°F. Considering the best physical properties attained, the optimum solid solution was a Ta-7W-3Re alloy which showed good ductility at −320°F, ductile welds in the recrystallized condition, and a high tensile strength at 3550°F. Chemical analyses showed that interstitial impurities when not deliberately added were below 50 ppM total, in the cast material. (auth)

27101 PROPERTIES OF Ta–W–Mo ALLOYS. Bartlett, E. S.; Schmidt, F. F.; Ogden, H. R. (Battelle Memorial Inst., Columbus, Ohio). Met. Soc. Conf., 34: 326-45(1966).

From Conference on High Temperature Refractory Metals, New York. See CONF-524-(Pt. 2).

Solid-solution strengthening of tantalum provides attractive combinations of high-temperature strength and low-temperature ductility and fabricability. The most attractive major additions of tungsten and molybdenum have been studied in detail. Effects of these additions on ductile-to-brittle transition behavior, stress rupture strengths, and cryogenic ductility of fusion welds are discussed. (auth)

27102 EVALUATION OF REFRACTORY METAL SHEET ALLOYS. Gazza, G. E.; Desisto, T. S. (Army Materials Research Agency, Watertown, Mass.). Met. Soc. Conf., 34: 346-74(1966).

From Conference on High Temperature Refractory Metals, New York. See CONF-524-(Pt. 2).

Five Nb-base alloys, three Ta-base alloys, and two Mo-base alloys were evaluated. Mechanical properties were determined by tensile testing, stress rupture testing, and bend testing of base metal specimens and welded specimens. The properties of the alloys are compared with target requirements as established by the Materials Advisory Board Refractory Metals Sheet Rolling Panel. Comparison of the tensile data obtained and the target properties shows that, in general, the elevated temperature strength levels of the alloys approach or satisfy target requirements. The elevated temperature strengths of the various alloys determined in tension or stress rupture, were generally somewhat similar in magnitude within each alloy group. Bend testing of the sheet alloys showed the Ta- and Nb-base alloys to be generally ductile to −320°F. Mo-base alloys had a much higher transition temperature of approximately −40°F. After welding, all six of the sheet alloys tested passed the 2T bend at room temperature successfully. Only the three tantalum alloys and the FS-85 alloy could pass a 1T bend at room temperature and a 4T bend at temperatures of −320 and −240°F. (auth)

27103 EFFECT OF IN-PROCESS SOLUTION HEAT TREATMENTS ON THE PROPERTIES OF THE TZM ALLOY. Kalns, E.; Barr, Robert Q.; Semchyshen, M. (Climax Molybdenum Co., Detroit). Met. Soc. Conf., 34: 375-90(1966).

From Conference on High Temperature Refractory Metals, New York. See CONF-524-(Pt. 2).

A relatively low-temperature solution treatment applied during the working schedule increased the room and elevated temperature strength of rolled TZM bars at three carbon levels. Data are presented to indicate that resistance to recrystallization is also enhanced by in-process solution treatments. The in-process treatments tended, however, to raise the transition temperature compared with conventionally processed TZM of the same carbon contents. The improvement in strength and recrystallization temperature is attributed to a more effective dispersion of excess phase material effected by the in-process solution anneals. (auth)

27104 EFFECT OF OXYGEN ON CREEP-RUPTURE OF NIOBIUM. Stoop, J.; Shahinian, P. (Naval Research Lab., Washington, D. C.). Met. Soc. Conf., 34: 407-32(1966).

From Conference on High Temperature Refractory Metals, New York. See CONF-524-(Pt. 2).

The creep-rupture properties of electron-beam melted niobium with additions of oxygen up to 0.35 weight per cent were determined at 1900°F, 2300°F, and 2600°F at vacuums of 1×10^{-5} torr or better. Rupture life generally increased and minimum creep rate decreased as the level of oxygen was raised. There was no deleterious effect on ductility even with the high oxygen additions. Increases in hardness as a function of cold work and oxygen content were obtained. Activation energies for high temperature creep were determined which showed good agreement with the reported experimental activation energies for self-diffusion. At 1900, but not at 2300 and 2600°F, an anomalous behavior occurred which was manifested by a rapid acceleration followed by a deceleration in the flow process. The irregularity which is represented as a step in the creep curve, occurs only under certain combinations of temperature, stress, and oxygen content, and appears to be related to substructure formation. (auth)

27105 COLUMBIUM–VANADIUM ALLOYS FOR ELEVATED-TEMPERATURE SERVICE. Babitzke, H. R.; Asai, G.; Kato, H. (Albany Metallurgy Research Center, Oreg.). Met. Soc. Conf., 34: 433-50(1966).

From Conference on High Temperature Refractory Metals, New York. See CONF-524-(Pt. 2).

An investigation was conducted to develop Nb alloys for use at elevated temperatures. A series of Nb–V alloys were prepared, and their properties, such as machinability, hardness, workability, tensile strength, and oxidation resistance were investigated. Tungsten, titanium, and/or zirconium were added to determine whether the alloys of Nb and V would be improved further. Test results showed that the alloys containing about 10 atomic percent V are promising and merit further development. Besides being workable at room temperature, the alloys have oxidation resistance superior to that of the other alloys investigated. The strength and hardness values increased with increasing V content and reached a maximum at 50 atomic percent. Adding W to Nb–V alloys increased the strength significantly but decreased oxidation resistance and ductility. V increased the oxidation resistance, and Zr was not helpful in any respect. (auth)

27106 MECHANICAL PROPERTIES OF ZONE REFINED COLUMBIUM AND TANTALUM. Thomas, M. K.; Tankins, E. S.; Erthal, J. F. (Aeronautical Materials Lab., Philadelphia). Met. Soc. Conf., 34: 451-68(1966).

From Conference on High Temperature Refractory Metals, New York. See CONF-524-(Pt. 2).

Observations made during the development of the electron beam and induction heating floating zone refining techniques are presented. The merits of each method are critically compared. Data are given on the mechanical properties of niobium and tantalum refined by either or both methods. Sections from the zone refined rods were tested in tension at a constant strain rate at temperatures ranging from that of liquid nitrogen to 1000°C. The elevated temperature tests were made in a vacuum. The mechanical properties as a function of temperature, impurity level, number of zone refining passes and orientation are discussed. After testing, all samples were analyzed for oxygen and nitrogen by the vacuum fusion method. (auth)

Structure and Phase Studies

Refer also to abstracts 26994, 27055, 27068, 27071, 27091, 27103, 27138, 27409, and 28230.

27107 (LA-tr-69-2) A CONTRIBUTION TO THE STUDY OF THE Pu–Zr PHASE DIAGRAM. Lauthier, J. C.; Housseau, N.; Van Craeynest, A.; Calais, D. Translated for Los Alamos Scientific Lab., N. Mex., from J. Nucl. Mater., 23: 313-19(1967). 15p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 21: 45948. (R.C.K.)

27108 (LA-tr-69-5) A CONTRIBUTION TO THE STUDY OF THE PLUTONIUM–THORIUM SYSTEM. Portnoff, A. Y.; Calais, D. Translated for Los Alamos Scientific Lab., N. Mex., from J. Nucl. Mater., 24: 158-63(1967). 16p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 22: 2652. (L.C.L.)

27109 (RD/B/N-1286) MICROSTRUCTURAL AND DIMENSIONAL CHANGES IN STRIPS OF MAGNOX-ZR55 EXPOSED TO CO_2 AT ELEVATED TEMPERATURES AND PRESSURES. Wood, J. C. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Jan. 1969. 13p. Dep. CFSTI.

Strips of the alloy Mg, 0.55% Zr were exposed to nuclear grade CO_2 at temperatures in excess of 500°C at pressures ~20 atm. The strip extensions in width and length were measured, and the strain rate was found to be increased by an order of magnitude when hydrocarbon vapours were present in the gas. Metallographic examination of the specimens revealed a duplex sub-structure in the metal; core and outer zones were separated by a narrow band of Zr-rich precipitate. At grain boundaries in the external zone, networks of bands, denuded of precipitate, were observed. These were preferentially aligned perpendicular to the strip surface and account for the measured macroscopic strain. The duplex nature of sub-surface structure was observed only beneath surface areas covered by black/grey deposits. (auth)

27110 FIELD-ION INVESTIGATIONS OF Ta–Mo SOLID SOLUTIONS. Raghavan, N. D.; Raganathan, S.; Thomas, G. (Univ. of California, Berkeley). J. Less-Common Metals, 18: 79-91(June 1969).

A field ion microscope study of the tantalum–molybdenum system was carried out at liquid hydrogen temperatures. The purpose of this investigation was twofold; the first being to increase knowledge on the field ion microscopy of alloys, and the second being to categorize the segregation effects which at high concentration levels embrittle the alloys. Micrographs were obtained from three alloys of composition Mo–8% Ta, Mo–50% Ta and Ta–10% Mo, respectively, and also from the two pure metals. The Ta–Mo alloy micrographs obtained show far more irregularity than those from W–Mo alloys. The greater regularity of the Mo–8% Ta micrographs over those from Ta–Mo was shown to be in accord with predictions based on field evaporation from dilute alloys, and the unexpected large difference in the regularity was accounted for by considering the polarization and heat of solution terms in the field evaporation equation. Computer simulation of images from clustered alloys was performed on the assumption that solute atoms do not participate in image formation. A band structure resulted when deviations from randomness become appreciable in the clustered alloy. The contrast to be expected from a demixed alloy in the Ta–Mo system was discussed, but the available experimental evidence did not reveal any such contrast effects. It was concluded that the width of such demixed zones probably exceeds 1000 Å. However, a tendency for local clustering on the [200] planes was observed in the Ta–50% Mo alloy. (auth)

27111 CRYSTAL STRUCTURE OF $R.E._5Tl_3$ AND Y_5Tl_3 COMPOUNDS. Franceschi, E.; Palenzona, A. (Univ., Genoa). J. Less-Common Metals, 18: 93-8(June 1969).

The formation of $R.E._5Tl_3$ phases, where R.E. = rare earths and yttrium, by direct reaction between the elements, and their crystal structures were investigated by micrographical and X-ray methods. For the phases formed by La, Ce, Pr, Nd and Sm, the W_5Si_3 structure type was found, while those of Gd, Tb, Dy, Ho, Er, Tm, Lu and Y the structure was of the hexagonal Mn_5Si_3 type. For Eu and Yb no phases with this composition could be obtained. (auth)

27112 ADVANCES IN X-RAY ANALYSIS. VOLUME 10. Proceedings of the Fifteenth Annual Conference on Applications of X-Ray Analysis Held at Denver, August 10–12, 1966. Newkirk, John B.; Maliett, Gavin R. (eds.). New York, Plenum Press, 1967. 566p. $22.50. (CONF-660814).

Separate abstracts were prepared for three of the forty-four papers included. The remaining papers were not in scope for Nuclear Science Abstracts. (L.M.T.)

For abstracts of individual papers see: 27066, 27329, and 28639.

27113 ELASTIC BULK EFFECT OF POINT DEFECTS IN METALS. Townsend, J. R. (Univ. of Pittsburgh); DiCarlo, J. A.; Nielsen, R. L.; Stabell, D. Acta Met., 17: 425-36(Apr. 1969).

The presence of point defects in a solid produces a change in the elastic moduli arising from the altered interatomic forces. The continuum theory of this "bulk effect" is discussed in detail. A major theoretical uncertainty remains regarding the effect of shear strains on the moduli. Experimental results are reported on the bulk effect on Young's modulus for Cu and W irradiated below 15°K with 10 MeV protons. Both metals give a negative bulk effect; the fractional change in Young's modulus per atomic fraction of interstitial-vacancy pairs is estimated to be −13 ± 3 for Cu and −13 ± 3 for W. These sizeable negative values suggest either a large negative shear strain effect as predicted by Zener or anelastic processes which are active at 4.2°K. (auth)

27114 BINARY EQUILIBRIUM DIAGRAMS BETWEEN METALS OF THE IVA, VA, AND VIA GROUPS. de Gelas, M. B. (Centre de Recherches Metallurgiques, Paris). Metaux (Corros.-Ind.), 43: 355-66(Oct. 1968). (In French).

The present knowledge on the binary equilibrium diagrams between transition metals of the IVA, VA, and VIA groups is briefly reviewed. Experimental results are then reported. These results show that these binary equilibrium diagrams have specific characteristics because of the aptitude of these metals to form continuous series of body-centered solid solutions. The characteristics include the sharp influence of the atomic size factor on the aptitude to form solid solutions, absence of a pronounced valence effect, and the presence of only one definite compound (a Laves phase having generally the structure of $MgCu_2$). (J.S.R.)

27115 INELASTIC PHENOMENA IN MOLYBDENUM DUE TO DIFFUSION. Baranova, V. I.; Golovin, S. A.; Krishtal, M. A.; Lerner, M. I. Fiz. Khim. Obrab. Mater., No. 2, 61-5(Mar.-Apr. 1968). (In Russian).

Inelastic phenomena taking place in zone-refined Mo as a result of diffusion were studied on the basis of internal-friction measurements. The temperature and amplitude dependence of the internal friction of samples subjected to various forms of preliminary treatment were obtained. There was a clear maximum of the damping factor at 120°C. The factors responsible for the appearance of this maximum were determined. The temperature dependence of the coefficient of diffusion of O atoms in the Mo lattice was also determined; this was given by the equation $D = 3 \times 10^{-2} \exp [-31{,}000/RT] cm^2/sec$. (Metals Abstr.)

27116 THE ROLE OF THE ALLOTROPIC TRANSFORMATION IN COBALT-BASE ALLOYS. II. Giamei, A. F.; Burma, J.; Rabin, S.; Cheng, M.; Freise, E. J. Cobalt, 40: 140-55(Sept. 1968).

Results which provide information on the solid state reactions occurring in the ternary Co–W–C system along the vertical isopleth Co–WC section are presented. Preliminary results on the effect of alloying additions on the allotropic transformation in Co–W and Co–Cr binary systems are given. For Co–>15% WC alloys heat-treated at 775 to 1300°C, the initiation of transformation on cooling occurs at ~900°C. A model involving a multi-step reaction and metastable state is proposed to explain the observed kinetic data for the allotropic transformation. Hardness data correlate with the extent of the transformation. Results for binary alloys indicate that they may follow similar reaction paths, and the allotropic transformation in these systems can be used to refine grain size. The problems involved in understanding the nature of the allotropic transformation and possibilities of thereby controlling mechanical properties are considered in relation to the results obtained. (Metals Abstr.)

27117 DISPERSION OF THE PRECIPITATE IN LOW-ALLOY URANIUM–ALUMINUM–IRON AND URANIUM–ALUMINUM–IRON–SILICON ALLOYS. Truchly, Jan; Novak, Jiri. Kovove Mater., 6: 290-2(1968). (In Czech).

Three different phases, UAl_2, U_3Si, and U_6Fe form simultaneously in these alloys, and occur as globular, lamellar or rod-like and globular particles, respectively. The distribution curve of the size of the particles compared with theoretical shows that certain particles grow more rapidly at the grain boundaries, block boundaries or at individual dislocations. Inhomogeneity of the dispersion of the precipitate is a result of inhomogeneity of the dislocation and block structure. During coarsening of the dispersion the proportion of particles growing at preferred sites gradually increases. The hardness of U–Al–Fe and U–Al–Fe–Si alloys is greater than that of U–Al alloy. Fe and Si additions probably contribute to solid-solution strengthening. In view of the solubility of Fe and Si in UAl_2 the minimum Fe and Si contents required for maximum strengthening of the solid solution in these alloys should be higher than the solubility of Fe and Si in α–U–U_6Fe and α–U–U_3Si binary systems, and dependent on the Al content of the alloy. When comparing the hardness of these alloys and of commercial pure U possible impoverishment of the α solid solution of the alloys in Fe, Si, and other additions must be considered. (Metals Abstr.)

27118 X-RAY METHOD FOR MEASURING PERCENTAGE OF ALPHA IN DELTA-STABILIZED PLUTONIUM ALLOYS. Jackson, Ross J.; Pinkney, Rodney J. (Dow Chemical Co., Golden, Colo.). Contract AT(29-1)-1106. Metallography, 1: 387-97(Jan. 1969).

A nondestructive, x-ray method for measuring the percentage of alpha plutonium in delta-stabilized plutonium alloys is described. The theory for the method is developed, and the constant for the theoretical equation as applied to the Pu–Ga system is evaluated experimentally. The sources and magnitudes of errors in the measurement are discussed. The method is then proved by using standards based on micromixtures and mechanical macromixtures. The limitation of the method and its extension to other systems are discussed. (auth)

27119 MICROSTRUCTURE OF LEAD-BASE ALLOYS. Mao, G. W.; Larson, J. G.; Rao, P. (Gould-National Batteries, Inc., Minneapolis). Metallography, 1: 399-423(Jan. 1969).

Systematic studies on pure lead and on seven binary and four ternary systems at various concentrations were conducted. The systems are: Sb–Pb, Ca–Pb, Li–Pb, Cd–Pb, Ag–Pb, As–Pb, Sn–Pb, As–Sb–Pb, Ag–Sb–Pb, Cd–Sb–Pb, and Sn–Sb–Pb. Over two thousand lead alloy specimens have been examined metallographically. The objective of the study was to develop lead-base alloys having superior physical and electrochemical corrosion resistance properties. Observed metallographic structures of the various binary and ternary lead alloys, cast under air or inert atmosphere and with controlled solidification rates are reported. The metallographic structures have been used to reveal the multicrystalline aggregation of phase or phases, to evaluate the grain size and grain growth, to detect grain boundary precipitation during age hardening, to detect microporosity and cracks in cast alloys, and to examine the nature of the corrosion attack mechanism on alloys subjected to anodic corrosion. A description of metallographic sample preparation techniques used on various lead alloys is presented. (auth)

27120 DISLOCATION MORPHOLOGY OF TANTALUM DEFORMED IN TENSION. Jewett, Robert P.; Weisert, Edward D. (Rocketdyne, Canoga Park, Calif.). Met. Soc. Conf., 34: 160-72 (1966).

From Conference on High Temperature Refractory Metals, New York. See CONF-524–(Pt. 2).

Dislocation morphologies of commercially pure tantalum observed by transmission electron microscopy are described and related to degree of strain. It was found that work hardening occurred when recrystallized material was deformed. Grain boundaries were shown to play an important role in the deformation process. In tantalum, grain boundary damage was significant with a Lüders band after 2% deformation and is considerable after 4% deformation. It has been shown that grain boundaries act as sources of dislocations during deformation and grain boundary deformation is an important dislocation-multiplication mechanism. (auth)

27121 A STUDY OF THE NIOBIUM–ZIRCONIUM–CARBON AND NIOBIUM–ZIRCONIUM–OXYGEN SYSTEMS. Barber, A. C.; Morton, P. H. (Imperial Chemical Industries (Kynoch) Ltd., Birmingham, Eng.). Met. Soc. Conf., 34: 391-406(1966).

From Conference on High Temperature Refractory Metals, New York. See CONF-524–(Pt. 2).

Stable carbide dispersions when present in a suitable form in niobium base alloys enhance high-temperature creep resistance and strength. Known dispersion-strengthened alloys are based on the niobium-zirconium-carbon system and the ternary diagram has therefore been investigated. Since zirconium also forms stable compounds with oxygen and nitrogen, which are always present as impurities, these alloys may also contain oxide or nitride dispersions and the niobium-zirconium-oxygen system has therefore also been studied. Isothermal sections of the niobium rich-corners of the Nb/Zr/C and Nb/Zr/O ternary systems, at 1300 and 1000°C respectively, are presented. Phase extraction, x-ray diffraction and conventional metallographic techniques were employed and the type, size, form, and dispersion of compounds was studied. In the Nb/Zr/C system, hexagonal Nb_2C and cubic ZrC were identified. At 1300°C ZrC exists in a dispersed coarse form, whereas Nb_2C is unsuitable for strengthening effects because it exists in coarse angular form and precipitates at grain boundaries. In the Nb/Zr/O system a fine dispersion has been observed. The isothermal section presented illustrates the marked reduction in oxygen solubility in niobium which is brought about by very small additions of zirconium. The solubility at 1000°C for instance is 3800 ppM in unalloyed niobium, while for niobium 1 wt % Zr it is less than 100 ppM. (auth)

Radiation Effects

Refer also to abstracts 26370, 26414, 26997, 27720, and 28597.

27122 (AD–681020) IRRADIATION EFFECTS ON REACTOR STRUCTURAL MATERIALS. Quarterly Progress Report, August 1–October 31, 1968. Steele, L. E.; Serpan, C. Z. Jr.; Hawthorne, J. R.; Potapovs, Uldis; Gray, Robert A. Jr. (Naval Research Lab., Washington, D. C.). Nov. 15, 1968. 48p. (NRL-MR–1937). CFSTI.

The radiation induced effects of long term operation upon steel plates are discussed. The results of three series of experiments are presented as the pre- and post radiation properties of various steels are compared. (USGRDR)

27123 (AD–681373) INITIAL ASSESSMENTS OF NOTCH DUCTILITY BEHAVIOR OF A533 PRESSURE VESSEL STEEL WITH NEUTRON IRRADIATION. Final Report. Hawthorne, J. Russell; Potapovs, Uldis (Naval Research Lab., Washington, D. C.). Nov. 22, 1968. 23p. (NRL–6772). CFSTI.

Exploratory assessments were made of the Charpy-V notch ductility characteristics of heavy section A533-B and A533-C steel plate and submerged arc weldments following neutron irradiation at 550°F. The experimental evaluations were performed largely with commercial production materials and included comparisons of materials in both Class I and Class 2 strength ranges. Postirradiation notch ductility properties of one 5¾-in. A533-B Class I electroslag weldment were also developed. Assessments made of relative irradiation performance were assisted by a compilation of recent information on the response of the ASTM reference A302-B steel plate. Major research findings include the observation of significant variability in radiation embrittlement sensitivity of A533-B and A533-C steel wherein the sensitivity level of plate and weld metal in some cases exceeded that of the ASTM reference plate. High radiation embrittlement sensitivity was noted for both submerged arc weld deposits examined; however, the data suggest that the performance of the weld-heat-affected zone parallels that of the parent plate. High embrittlement sensitivity was also noted for the electroslag weld deposit, in contrast to markedly low sensitivity of the weldment parent plate. The notch ductility behavior of A533 plate and weld metal under 550F irradiation was not found to be measurably influenced by either the strength class (Class 1 or 2) or by the particular grade of steel (Grade B or C). Similarly, there were no marked variations in irradiation response through the thickness of plate or weld metals, or between RW (longitudinal) versus WR (Transverse) orientations in cross-rolled plate. (USGRDR)

27124 (BNWL-SA–1992) FRACTURE TOUGHNESS OF IRRADIATED AND UNIRRADIATED HEAVY SECTION PRESSURE VESSEL MATERIAL. Claudson, T. T.; Williams, J. A.; DeMastry, J. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). July 15, 1968. Contract AT(45-1)-1830. 26p. (CONF-681209–2). Dep. CFSTI.

From Winter Annual Meeting of the American Society of Mechanical Engineers, New York.

Fracture toughness characteristics of irradiated and unirradiated A533B are given. The plane strain fracture toughness, (K_{Ic}) for A533-B is about 40 ksi $\sqrt{in.}$ at −160°C and increases to about 65 to 70 ksi $\sqrt{in.}$ as test temperatures increase to −80°C. Fracture arrest, (K_{Ia}) values show a similar temperature dependency and are about 6 to 7 ksi $\sqrt{in.}$ below the initiation values. The plane strain fracture toughness is elevated 25 to 30% at the surface of the 12 in. A533-B quenched and tempered plate tested in these investigations. A validity criterion for testing low strength steels using the DCB specimen was determined to be $w/(k_{Ic}/\sigma_{ys})^2 \geq 1.4$ or $B/(K_{Ic}/\sigma_{ys})^2 \geq 4$ where w is the net thickness and B is the gross thickness. Initial results from fracture toughness determined on PM-2A agree well with a value of $K_{Ic} = 84{,}800$ psi $\sqrt{in.}$ calculated from the failure conditions of the PM-2A vessel test. (F.S.)

27125 (KFK–383) THE FORMATION OF VOIDS IN METALS BY NEUTRON IRRADIATION. Boehm, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material und Festkoerperforschung). Sept. 1968. 52p. (In German). Dep.

The previously known data on the formation of voids in metals as a result of radiation were summarized, and a review was given of the models for the origin of void formation in order to give the effect of various parameters on the formation of voids and the property modifications caused by the voids. The compilation of theory and previous experimental study was intended as a guide to further experimental and theoretical treatment of the formation of voids. (tr-auth)

27126 (N–69-14651) EFFECTS OF INTERIM WARMING ON TENSILE PROPERTIES OF A 286 STAINLESS STEEL IRRADIATED AT CRYOGENIC TEMPERATURES. (Lockheed-Georgia Co., Marietta). Oct. 1968. Contract NAS3-10298. 45p. (NASA-CR–72475; LAC-ER–10008). CFSTI.

The results obtained in an experimental study of the effects of irradiation at cryogenic temperatures on the tensile properties of Type A-286 stainless steel, ASM 5735 are reported. Test specimens were exposed to fluences of 6×10^{17} n/cm^2 and 9×10^{17} n/cm^2, with neutron energies greater than 0.5 MeV (80 femtojoules) at 17°K (30°R). Sets of specimens were irradiated continuously to the desired fluence; other sets were irradiated in increments of 3×10^{17} n/cm^2, with interim warming to 300°K (540R), until the desired fluence was attained. The interim temperature was maintained for one hour between incremental irradiations. The sample lots tested after continuous irradiation exposure showed no effect of irradiation on the ultimate tensile strength reliably discernible within the sensitivity of the test procedures. A small increase in the tensile yield strength was observed with increasing fluences; no such effect had been observed after exposure to 1 × 10^{17} n/cm^2 at 17°K (30°R) in an earlier program. The effect of total irradiation fluence on the tensile yield strength appeared to be independent of interim warming during interrupted irradiations at the 95% confidence level (probability of obtaining a value equal to ± the desired significance ratio is 0.05). (auth) (STAR)

27127 (ORNL-4369) RADIATION METALLURGY SECTION, SOLID STATE DIVISION PROGRESS REPORT FOR PERIOD ENDING OCTOBER 1968. (Oak Ridge National Lab., Tenn.). Apr. 1969. Contract W-7405-eng-26. 57p. Dep. CFSTI.

The report is divided into six sections. A separate abstract was prepared for each section. (J.R.D.)

For abstracts of individual sections see: 27054 and 27128–27132.

27128 (ORNL-4369, pp 1-9) RADIATION HARDENING AND EMBRITTLEMENT IN ASTM A 212-B STEEL. Hinkle, N. E.; Berggren, R. G.; Stelzman, W. J.; Jones, T. N.; Wechsler, M. S.; Case II, C. R. (Oak Ridge National Lab., Tenn.).

Results of studies on radioinduced embrittlement of A 212-B, A 302, A 533-B, and A 543 steels are presented. (J.R.D.)

27129 (ORNL-4369, pp 9-16) ELECTRON FRACTOGRAPHY OF IRRADIATED A 212-B PRESSURE-VESSEL STEEL. Brooks, C. R.; Miller, J. L.; Wechsler, M. S. (Oak Ridge National Lab., Tenn.).

Morphological features commonly found on brittle fracture surfaces of pressure vessel steel are characterized in relation to heat treatment and irradiation. (J.R.D.)

27130 (ORNL-4369, pp 16-21) RADIATION HARDENING AND EMBRITTLEMENT IN ASTM A 533-B STEEL. Berggren, R. G.; Stelzman, W. J.; Jones, T. N.; Wechsler, M. S. (Oak Ridge National Lab., Tenn.).

Specimens were irradiated at 66, 232, and 288°C. Tensile and impact test results for these specimens are presented. (J.R.D.)

27131 (ORNL-4369, pp 29-41) RADIATION HARDENING IN IRON. Ohr, S. M.; Hinkle, N. E.; Wechsler, M. S. (Oak Ridge National Lab., Tenn.).

Results of investigations on radiation hardening in iron, and on effects of interstitial solutes in irradiated iron are presented. (J.R.D.)

27132 (ORNL-4369, pp 42-52) TRAPPING OF INTERSTITIAL IMPURITIES IN VANADIUM DEFECTS PRODUCED BY RADIATION. Williams, J. M.; Brundage, W. E.; Stanley, J. T. (Oak Ridge National Lab., Tenn.).

Information is included on sample preparation, measurement methods, and annealing and irradiation procedures. (J.R.D.)

27133 (ORNL-TM-1362) FACTORS AFFECTING THE MECHANICAL PROPERTIES OF STAINLESS STEELS AT MPRE OPERATING TEMPERATURES. Martin, W. R. (Oak Ridge National Lab., Tenn.). Feb. 1966. Contract W-7405-eng-26. 22p. Dep. CFSTI.

The mechanical properties pertinent to use in the MPRE for types 304 and 316 stainless steel were reviewed. The strength of the unirradiated wrought materials is adequate, but the lower strength of weld metal will have to be considered in design. Irradiation has a greater effect on ductility than does temperature; quantitative information on radiation embrittlement in creep is inadequate. (auth)

27134 ON THE TEMPERATURE DEPENDENCE OF THE FLOW STRESS IN SOME BODY-CENTERED CUBIC METALS. Soo, P.; Galligan, J. M. (Brookhaven National Lab., Upton, N. Y.). Scr. Met., 3: 153-5(Mar. 1969).

Experiments are described and results given in which lattice defects have been introduced into prestrained Ferrovac E iron and zone-refined tungsten single crystals. After fast neutron bombardment at 90°C, the temperature dependences of the flow stress were measured. The thermal component of the flow in both metals has been charged by the introduction of changes in defect densities. This is inconsistent with the contention that the Peierls-Nabarro stress is solely rate determining in the temperature dependent range of the flow stress in bcc metals. (J.C.W.)

27135 RADIATION AND TEMPERATURE STABILITY OF FERRITES WITH RIGHT-ANGLED HYSTERESIS CHARACTERISTICS. Bondarev, D. E.; Zakharov, A. I. Porosh. Met., Akad. Nauk Ukr. SSR, No. 1, 56-61(Jan. 1969). (In Russian).

Comparative data are presented of radiation stability of ferrite and metal cores under the conditions of irradiation with $1 \cdot 10^{16}$ to $1 \cdot 10^{19}$ neutrons/cm^2. It is established that ferrite cores are more radiative-resistant than the cores made of permalloy of 50NP and 79NP. Oscillograph characteristics of flow and time dependences of ferrite and metal cores before and after irradiation are given. The data are presented on ferrite hysteresis characteristic degeneration at various temperatures. (auth)

27136 ION INDUCED RE-EMISSION OF NOBLE GAS ATOMS FROM POLYCRYSTALLINE TUNGSTEN. II. Erents, K.; Carter, G. (Culham Lab., Abingdon, Eng.). J. Phys., D (London), 2: 711-16(May 1969).

Measurements were made to obtain the gas sputtering yield as a function of (a) primary ion dose, (b) primary ion energy and (c) secondary ion energy for various inert gas ion types injected into polycrystalline tungsten during secondary ion bombardment. A qualitative model for the gas sputtering process is suggested in which target atom collision cascades are assumed to play an important role. (auth) (UK)

27137 RADIATSIONNAYA FIZIKA PROCHNOSTI METALLICHESKIKH KRISTALLOV. (Radiation Physics of Stability of Metallic Crystals). Troitskii, O. A.; Shteinberg, V. G. Moscow, Atomizdat, 1969. 80p.

Data on the radiation physics of the stability and ductility of metallic crystals are briefly reviewed. The dynamics of radioinduced damage, internal friction, creep, stability, and plasticity of metal crystals were studied. The cascade theory of dislocation, collision focusing, channeling process of particles and ejected atoms in crystalline lattices, and interactions of focusing collisions are discussed. (138 references). (R.V.J.)

27138 RADIATION-INDUCED GROWTH OF QUENCHED URANIUM. Ivanov, V. E.; Zelenskii, V. F.; Kunchenko, V. V.; Vorob'ev, M. A.; Stukalov, A. I. At. Energ. (USSR), 26: 227-30(Mar. 1969). (In Russian).

The behavior of quenched uranium under irradiation was studied. It was found that the fuel element cores having a distinct [010]-type texture along the core axis undergo the most elongation in the low temperature irradiation region. Cores having a slight [100]-type texture along the core axis, elongate only at irradiation temperatures above 400°C and there were no changes observed in core dimensions at irradiation temperatures most favorable to the radiation-induced growth. It was also found that radiation-induced growth coefficient for uranium rods with low perferred orientation is lower than was calculated using theoretical parameters. (auth)

Ceramics and Cermets

Refer also to abstracts 26984 and 26985.

27139 NEW WORLD OF COMPOSITES: WHAT WE CAN EXPECT IN THE 1970's. Fleck, James N.; Jablonowski, Edward J. (Battelle Memorial Inst., Columbus, Ohio). Metal Progr., 95: No. 3, 99-103(Mar. 1969).

Commercial and experimental fiber-matrix combinations are summarized. Boron and graphite composites appeared to be the most promising from a strength to density aspect. Methods for the preparation of the fiber-matrix composite and for the fabrication of the finished combination are discussed. Although these composites have shown great promise from a technical standpoint their present high production cost has concentrated the present use of composites to planes and spacecraft where weight-saving is critical. (G.M.C.)

Corrosion and Erosion

Refer also to abstracts 26999 and 27183.

27140 (KFK-885) INVESTIGATION OF THE COMPATIBILITY OF URANIUM MONONITRIDE WITH MOLYBDENUM TUNGSTEN, AND THORIUM OXIDE AT HIGH TEMPERATURE. Politis, C.; Thuemmler, F.; Wedemeyer, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material und Festkoerperforschung). Dec. 1968. 20p. (In German). Dep.

On annealing of uranium mononitride and UN–Mo mixtures on molybdenum supports above 2000°C under a vacuum of 10^{-2} to 10^{-5} torr an increase in the UN lattice parameter could be observed at room temperature. It is assumed that this change in the lattice is caused by the solubility of molybdenum (0.23 wt %) in UN. The decomposition of UN initiated at high temperatures under vacuum results in a γ–U–Mo phase, which can be detected by metallographic and x-ray methods; by microprobe analysis about 21 to 22 wt % of Mo and 78 wt % of U were detected. Moreover, the microanalytical studies yielded considerable fractions of nitrogen (about 1 wt %). On the molybdenum supports UO_2 crystals oriented in [111] direction can be detected subsequent to annealings at 2400°C. X-ray studies on annealed UN–W specimens did not give indications on possible reactions or solubilities. Changes in the lattice parameters could not be observed. On annealing of UN–ThO_2 mixtures on tungsten and ThO_2 supports no remarkable change in the UN lattice parameter was detected up to 2400°C under 500 torr of nitrogen. On annealing supports of molybdenum a slight change of $\Delta a_0 = 0.005$ Å was measured following annealings at 1750 and 2000°C under vacuum. However, the UO_2 impurities form a mixed crystal together with thorium oxide, which can be observed by the variation of the lattice constants. The temperature limit for satisfying compatibility strongly depends on the annealing atmosphere. In the case of UN–Mo under 10^{-5} torr of N_2 it is at 1550 and rises to about 2300°C under 300 torr of N_2. Slightly higher temperatures are applicable to UN–W. (auth)

27141 OKISLENIE TUGOPLAVKIKH SOEDINENII. (Oxidation of Refractory Materials). Voitovich, R. F.; Pugach, E. A. Kiev, Naukova Dumka, 1968. 84p.

Tabulated data are given on the oxidation resistance of borides, carbides, silicides, and their alloys with high-melting metals. A systematic tabulation is included of the oxidation magnitudes as functions of time and temperature. 42 references. (R.V.J.)

27142 HIGH-TEMPERATURE CHEMISTRY OF SIMPLE METALLIC OXIDES. Alcock, C. B. (Imperial Coll. of Science and Tech., London). Chem. Brit., 5: 216-23(May 1969).

Corrosion by metal oxide formation is an important factor in limiting the use of metals at high temperatures. To control this form of corrosion knowledge is needed of the thermodynamics, structure and vaporization of metal oxides at high temperatures, and the present state of this knowledge is described. Oxides covered include BeO, Ac_2O_3, ZrO_2, Nb_2O_5, WO_3, UO_2, ThO_2, etc. (auth) (UK)

Preparation and Fabrication

Refer also to abstracts 26999, 27025, 27179, and 28562.

27143 (BNWL-SA-1962) FTR FUEL SUBASSEMBLY PROCESS DEVELOPMENT. Powers, H. G.; Millhollen, M. K. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). July 9, 1968. Contract AT(45-1)-1830. 4p. (CONF-681101-26). Dep. CFSTI.

From International Conference on the Constructive Uses of Atomic Energy, Washington, D. C.

Major factors to be considered in the selection of unit processes and control techniques for fabricating FTR fuel subassemblies (excluding fuel pins) are reviewed. A fabrication process for the reference design FTR subassembly is described and process experience gained in fabricating full scale subassemblies for hydraulic testing in flowing Na and water are discussed. A shielding concept for protection of assembly personnel was devised based on calculations and process requirements. (F.S.)

27144 (CEA-R-3765) STABILIZATION OF MIXED CARBIDES OF URANIUM–PLUTONIUM BY ZIRCONIUM. PART I. URANIUM CARBIDE WITH SMALL ADDITIONS OF ZIRCONIUM. Bocker, Shimon (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Mar. 1969. 65p. (In French). Dep.

Samples of uranium carbide with small additions of zirconium (1 to 5%) were cast, as rods, in an arc furnace. A single phase carbide was produced. As cast, a dendrite structure is observed, which does not disappear, after a treatment of 1900°C during 110 hours. In comparison with uranium monocarbide the compatibility with stainless steel is much improved. The specific heat (between room temperature and 2500°C) is similar to the specific heat of uranium monocarbide. A study of these mixed carbides, but having a part of the uranium replaced by plutonium is under way. (auth)

27145 (LIB/Trans-188) THE INDUSTRIAL PRODUCTION OF URANIUM OXIDE SUITABLE FOR SINTERING AT THE BOUCHET PLANT. Delange, M. Translated by Marianne Balin (Australian Atomic Energy Commission), from Conference on New Nuclear Materials Including Non-Metallic Fuels, Vienna, 1963. 18p. Dep.

An abstract of this paper, prepared from the original language, appeared as NSA 17: 33277. (L.C.L.)

27146 (RFP-1255) FABRICATION OF OXIDE NUCLEAR FUEL PELLETS. Harvey, Malcolm R.; Teter, Alton R.; Leggett, Ronald L. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Mar. 21, 1969. Contract AT(29-1)-1106. 42p. Dep. CFSTI.

A small number of uranium dioxide and mixed uranium–plutonium dioxide fuel pellets were fabricated by the cold press and sinter technique. The diametral variations observed were less than ±0.003 in. based on a nominal diameter of 0.345 in. The average hourglassing was 0.003 in. for a length to diameter ratio of 1.5. It was concluded from this data and a literature survey that these variations could be maintained on a production basis and thus eliminate centerless grinding from the fabrication process. (auth)

27147 INDUSTRIAL FABRICATION OF NUCLEAR FUEL ELEMENTS. DeMaret, E. Bull. Belgicatom, 13: No. 3/4, 27-31(Oct.-Dec. 1968). (In French).

The industrial fabrication of fuel elements for the SENA pressurized water reactor is described. The reactor uses uranium oxide fuels in the form of prisms. The fabrication of the fritted tablets and fuel pins and the assembly of the fuel elements are described. The quality control and the safety precautions are considered. (J.S.R.)

27148 IMPREGNATION OF GRAPHITE WITH REFRACTORY CARBIDES. Langrod, K.; Jones, R. L. (to U. S. Atomic Energy Commission). U. S. Patent 3,432,336. Mar. 11, 1969.

A method of impregnating graphite with refractory metal carbides is described. A solution of a refractory metal salt, preferably an aqueous solution of an organic compound of a refractory metal such as an oxalate or acetate, is impregnated in the pores of a graphite member. The refractory metal salt is next hydrolyzed, preferably with a basic reagent which does not leave trace metal ions, to form the oxide or hydroxide. The hydrolyzed salt is then calcined at an elevated temperature in a non-oxidizing atmosphere, preferably at a temperature of about 1500 to 2400°C, in a vacuum or a noble gas, to yield the final product of a graphite body impregnated with a refractory metal carbide. (auth)

27149 METHOD FOR PRODUCING A HOLLOW NUCLEAR FUEL ROD. Torikai, Kinichi (to Japan Atomic Energy Research Inst.). Japanese Patent 1968-28515. Dec. 7, 1968. Filed Sept. 8, 1965.

A method for the economical fabrication of a nuclear fuel rod with an axial empty space of a given diameter is described. A mandril of large elongation and strength is inserted axially through the cladding tube. The space produced within the tube is filled with finely divided fuel material, then the whole is processed suitably. The mandril is pulled outward from both ends, allowing it to diminish in diameter. Finally, the mandril is pulled out from one end, leaving behind the desired axial empty space in the fuel rod. (NSA of Japan)

27150 SOLID SOLUBILITY IN THE SYSTEM ZIRCON–HAFNON. Ramakrishnan, S. S.; Gokhale, K. V. G. K.; Subbarao, E. C. (Indian Inst. of Tech., Kanpur). Mater. Res. Bull., 4: 323-8(May 1969).

Hafnium and zirconium silicates were synthesized from the constituent oxides. In both cases, synthesis was essentially complete after heating for 24 hours at 1450°C. X-ray diffraction studies confirmed complete solid solubility in the system $ZrSiO_4$–$HfSiO_4$. (auth)

27151 ENTHALPIES OF FORMATION OF PLUTONIUM DIOXIDE AND PLUTONIUM MONONITRIDE. Johnson, Gerald K.; Van Deventer, Erven H.; Kruger, Owen L.; Hubbard, Ward N. (Argonne National Lab., Ill.). J. Chem. Thermodynamics, 1: 89-98(1969).

The energies of combustion in oxygen of α-plutonium metal and plutonium mononitride were measured in a bomb calorimeter. The standard enthalpies of formation, ΔH_f°(298.15°K), of PuO_2(c) and PuN(c) were calculated to be $-(1055.85 \pm 0.72)$ kJ mol^{-1} [$-(252.35 \pm 0.17)$ kcal mol^{-1}] and $-(299.2 \pm 2.6)$ kJ mol^{-1} [$-(71.51 \pm 0.62)$ kcal mol^{-1}], respectively. (auth) (UK)

27152 TITANIUM–ZIRCONIUM TRIIODIDES $Ti_xZr_{(1-x)}/I_3$. Bhatti, M. A.; Copley, D. B.; Shelton, R. A. J. (Univ. of Manchester, Eng.). J. Less-Common Metals, 18: 99-104(June 1969).

The synthesis of members of the iso-structural series $Ti_xZr_{(1-x)}I_3$ (D_{6h}^{3}-$P6_3$(mcm)), from the metals and their tetraiodides is described. Their crystal lattice parameters are found to lie on a smooth curve drawn between the end members TiI_3 and ZrI_3. The difficulty of retaining zirconium in the titanium-rich compound, and the resulting non-stoichiometry, is discussed in terms of the partial disproportionation of the compound. (auth)

27153 PREPARATION AND STRUCTURE OF ZIRCONIA SPHERES. Madeyski, A.; Smeltzer, W. W. (McMaster Univ., Hamilton, Ont.). Mater. Res. Bull., 2: 427-35(1967).

From International Conference on Characterization of Materials, University Park, Pa. See CONF-661126.

A laboratory method is described for preparation of zirconia spheres 50 to 200 microns in diameter and consisting of only a few grains. The essential preparatory step involves spheroidizing in a reducing electric arc with carbon electrodes and a helium atmosphere which results in the formation of non-stoichiometric oxide spheres with improved ductility. Upon cooling, these spheres remain uncracked even though the oxide undergoes a phase transition with a large volume change at relatively low temperatures. The spheres which may exhibit a two-phase structure due to segregation of oxygen saturated metal, are then re-oxidized to fully stoichiometric oxide at temperatures below the transition range. (auth)

27154 GROWTH OF SINGLE CRYSTALS OF $Pb_3MgNb_2O_9$ BY THE KYROPOULOS TECHNIQUE. Bonner, W. A.; Van Uitert, L. G. (Bell Telephone Labs., Inc., Murray Hill, N. J.). Mater. Res. Bull., 2: 131-4(1967).

From International Conference on Characterization of Materials, University Park, Pa. See CONF-661126.

Single crystals of $Pb_3MgNb_2O_9$ can be grown from a $PbO-B_2O_3$ flux by the Kyropoulos technique. Good results have been obtained by growth onto a seed mounted on an air cooled cold finger while slowly cooling the melt from ~1150°C to hasten growth. By virtue of an invariant composition, a second order ferroelectric to paraelectric transition (at −8°C) and a very high resistivity; $Pb_3MgNb_2O_9$ exhibits a stability to temperature and dc bias that makes it of interest for electro-optic studies. (auth)

27155 CHOICE OF OXIDE PHASES FOR THE DISPERSION HARDENING OF METAL-BASE COMPOSITIONS. Kulikov, I. S.; Matveev, G. M.; Rudoi, B. L.; Shorshorov, M. Kh. Fiz. Khim. Obrab. Mater., No. 4, 118-24(July-Aug. 1968). (In Russian).

The general criteria governing the selection of oxide phases for the dispersion hardening of metal-base compositions are discussed on the basis of thermodynamic calculations of the interactions between metals and oxides at 1000 to 1800°C. In a neutral atmosphere in which there is no interaction between the metal base and the dispersion-hardening oxide, best results are ensured by choosing pairs formed from metals the oxides of which have a high incremental Gibbs free energy such as Ni, Co, and Fe, and oxides with a low value of this parameter such as BeO, MgO, HfO_2. If such interaction does take place, it is best to choose metals the oxides of which have a low incremental Gibbs free energy such as Hf, Zr, and Al, and oxides with a high value of this parameter such as SiO_2, TiO_2. These criteria are modified in the presence of an oxidizing atmosphere. (Metals Abstr.)

27156 BORON CARBIDE RESISTS HEAT. McCreight, Louis R. Metal Progr., 95: No. 3, 110; 113-14; 116(Mar. 1969).

The use of boron carbide for filament-reinforced structures that require metal matrices and consequently are fabricated at high temperatures is discussed. Boron carbide was used as the filament to reinforce aluminum, nickel, titanium, and their alloys and was stable up to 900°C. The fabrication and properties of the boron carbide filaments are described. Silica-based filaments were also prepared. The use of silica as a preliminary core has an economic advantage and may also result in a more stable filament. (G.M.C.)

27157 NEW WORLD OF COMPOSITES: BORON-EPOXY SYSTEMS IN ACTION. Howeth, Marvin S.; Hocking, John S. (General Dynamics Corp., Ft. Worth, Tex.). Metal Progr., 95: No. 3, 104-5(Mar. 1969).

The composition, production and processing of boron-epoxy composites are discussed. The boron composites have high strength-to-weight and high stiffness-to-weight ratios. The big disadvantage of these composites is the high cost of processing and production. (G.M.C.)

27158 CONSISTENT SET OF THERMODYNAMIC VALUES FOR PLUTONIUM MONONITRIDE. Spear, Karl E.; Leitnaker, James M. (Oak Ridge National Lab., Tenn.). J. Amer. Ceram. Soc., 51: 706-9(Dec. 21, 1968).

Values given in the literature for the heat of formation of plutonium mononitride range from −70 to −76 kcal/mole. It is shown that if estimated entropy and high-temperature heat capacity data are used to derive a reasonable set of high-temperature thermal functions for the mononitride, $\Delta H^0_{f,298}(PuN)$ values obtained by both second- and third-law methods from equilibrium data agree. The equilibrium data are from measurements reported in the literature and cover a range from 700 to about 3040°K. A calorimetric value of −70.2 kcal/mole reported for the PuN heat of formation appears to be in disagreement with the derived equilibrium value of −76.0 kcal/mole, but this difference can be explained by a composition uncertainty. (auth)

27159 EFFECT OF WATER VAPOUR ON THE SINTERING OF BERYLLIA. Clare, T. E. (Australian Atomic Energy Commission Research Establishment, Sydney). J. Aust. Ceram. Soc., 4: No. 2, 1-8(Nov. 1968).

The effects of water vapor (40−23,000 ppM) in a nitrogen atmosphere on the sintering kinetics of beryllia powder compacts have been investigated at 1050 to 1450°C. Densification is impeded by water vapor and the threshold temperature and moisture level depend on powder origin and heating rate. It is argued on the basis of sintering theory, and of some recent observations on the effect of moisture on the calcination of beryllia, that a reduced densification rate can be due to other factors besides the generally accepted evaporation-condensation mechanism. (auth)

27160 METHOD FOR PRODUCING A SINTERED BODY OF SPHERICAL UO_2 GRAINS. Mizusawa, Takashi (to Sumitomo Metal Mining Co., Ltd.). Japanese Patent 1969-5558. Mar. 8, 1969. Filed Aug. 25, 1964.

A method proposed for sintering spherical UO_2 grains has the advantages such as powder density of 10.6 g/cm^3; free adjustment in the grain size and in the grain-size distribution; and the process economy. Uranium dioxide, UO_3, or U_3O_8 in the form of powder is used as the starting material. The grains are obtained by adding a grain-producing agent as a thin film on the surface. The grains are dispersed in a pressurizing medium, and pressure is applied to obtain the high density. To produce a high-density sintered body of spherical UO_2 grains, the process of sintering is done at a temperature over 1400°C, in the atmosphere of hydrogen for U_3O_8 and UO_2, and of hydrogen or in vacuum for UO_2. (NSA of Japan)

27161 PROPOSED MECHANISM OF SILICIDE COATING FORMATION ON MOLYBDENUM ALLOYS BY REACTION WITH SILICON IODIDES. Gunderson, J. M.; Dreisbach, W. G. (Boeing Co., Seattle). Met. Soc. Conf., 34: 44-58(1966).

From Conference on High Temperature Refractory Metals, New York. See CONF-524-(Pt. 2).

With the iodide process for silicide coating high molybdenum alloys, coating formation is shown to be more rapid and radically different at temperatures below 1600°F when compared with coating formation above 1700°F. It is apparent that coating formation is solid state diffusion controlled at high temperatures while in the low temperature region it is controlled by the exterior surface chemical reaction rate. Effects of coating temperature on coating rate are correlated by the Arrhenius relationship and rate equations are presented which describe coating formation in both temperature regions. The high temperature coating obtained by the iodide process is essentially pure tetragonal molybdenum disilicide while the low temperature coating is primarily a previously unreported hexagonal molybdenum disilicide. Coating formation at edges as well as inert marker studies demonstrate that new coating is formed at the coating metal interface by silicon diffusion through the coating. Crystal structures of the two forms of silicide are compared in discussing differences in diffusion rates. A reaction mechanism is proposed which explains the coating rate behavior in both temperature regions including the observed catalytic effect of metallic surface contaminants. (auth)

Properties Evaluations

Refer also to abstracts 26209, 27006, 27023, 27144, 27157, 27159, 27184, 28547, and 28562.

27162 (BNWL-989) THERMAL CONDUCTIVITY AND ELECTRICAL RESISTIVITY OF URANIUM OXYCARBIDE. Bates, J. Lambert (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 1969. Contract AT(45-1)-1830. 45p. Dep. CFSTI.

The thermal diffusivity (α) of uranium oxycarbide was measured from 100 and 1500°C as a function of oxygen concentration from 2 to 17 at.%. Thermal diffusivity decreased as oxygen content increased. Oxycarbides with the lowest oxygen content showed a decrease in α as temperature increased, whereas oxycarbides with the highest oxygen contents exhibited an increase in α as temperature increased. Thermal diffusivities of all specimens approach a common value of 0.05 cm^2/sec at the high temperatures. Calculated thermal conductivities near 1500°C are about 0.18 W/cm-°C, very near the reported values for nearly stoichiometric and slightly hypostoichiometric UC. Electric resistivity of uranium oxycarbides between room temperature and 1775°K increased as oxygen concentration increased from 2 to 16 at.%. Electronic thermal conductivity is predominant above about 1200°C; phonon conductivity is predominant at lower temperatures and decreases with increasing oxygen content. (auth)

27163 (CEA-R-3764) THERMAL DIFFUSIVITY MEASUREMENTS BETWEEN 0°C AND 2000°C: APPLICATION TO UO_2. van Craeynest, Jean-Claude; Weilbacher, Jean-Claude; Lallement, Robert (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Mar. 1969. 48p. (In French). Dep.

Two types of apparatus were constructed to measure the thermal diffusivity of ceramic fuels. The first apparatus, based on Angstroem's method, operates between 0 and 1000°C. Satisfactory results have been obtained for iron, nickel and molybdenum. The other apparatus, based on Cowan's method, operates between 1000 and 2000°C on thin slabs. The thermal conductivity of UO_2 has been measured from 0 to 2000°C. Results agree with well known values for UO_2. (auth)

27164 (JUL-562-RW). MEASUREMENT OF THE MODULUS OF ELASTICITY OF THE OUTER LAYER ON SINGLE FUEL PARTICLES (COATED PARTICLES) PERPENDICULAR TO THE SURFACE. Delle, W.; Drittler, K.; Haag, G.; Schiffers, H. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorwerkstoffe). Nov. 1968. 21p. (In German). Dep.

The modulus of elasticity of the outer layer perpendicular to the surface can be determined in pressure studies on coated particles between two planes from the penetration depth and the pressure applied. The penetration depth must be small in comparison to the thickness of the outer coating. The values obtained agree well with previous measurements of the modulus of elasticity of pyrocarbon plates parallel to the separation surface. (tr-auth)

27165 (N-68-32983) THERMAL CONDUCTIVITY OF COATED PARTICLE URANIUM DIOXIDE-TUNGSTEN CERMETS. Grossman, L. N. (General Electric Co., Pleasanton, Calif. [Vallecitos Nuclear Center]). Aug. 1968. Contract NAS3-8511. 27p. (NASA-CR-1154). CFSTI.

The thermal conductivity of cermets fabricated by hot-pressing of tungsten coated uranium dioxide was measured. Data obtained from specimens containing nominally 80 and 60 vol % UO_2 were compared with theoretical predictions based on Bruggman's model. Excellent agreement was found between theory and experiment in the 80 vol % case in the temperature range of 900 to 1500°C. Less satisfactory agreement was obtained in the 60 vol % case between 600 and 1700°C; the discrepancies could not be explained. The experimental technique, specimen preparation, experimental results and post-experiment metallography are presented. (STAR)

27166 (TRG-Report-1793) DEFORMATION AND FRACTURE BEHAVIOUR OF ZIRCONIUM-HYDROGEN ALLOYS. Warren, M. R.; Beevers, C. J. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). Oct. 30, 1968. 38p. (HWR-FEMWG/P-(68)365). Dep. CFSTI. UK.

Zr-H alloys containing 25, 50 and 100 ppM H were tested at various temperatures at a strain rate of 5×10^{-4} sec^{-1}. Two distinct stages in the fracture of the hydride platelets could be distinguished: Stage I, the nucleation of cracks transverse to the major dimensions of the platelets; and Stage II, the formation of in-plane cracks which propagate in directions parallel to the major dimensions of the platelets. Stage I was related to the intersection of the platelets by matrix twins and slip bands and as such it exhibited both stress and strain control. A mechanism for transfer from Stage I to Stage II was set up, and it was demonstrated that Stage II was not achieved until the spacing of the transverse cracks was of the order of the platelet thickness. During Stage II the initial formation of the in-plane cracks was apparently controlled by a normal stress condition, but growth during a later part of this stage was closely related to the overall plastic strain of the material. The grain size dependence of fracture stress at -196°C exhibited the relationship $\sigma_f = \sigma_0 + k_f d^{1/2}$, where k_f was significantly reduced by increasing hydrogen content. A new interpretation of k_f is presented and subsequently utilized to examine several instances where k_f is modified either by the presence of brittle second-phase particles or by a change in fracture mode with grain size. (auth) (UK)

27167 (UCRL-71316) FATIGUE BEHAVIOR OF A HIGH DENSITY GRAPHITE AND A GENERAL DESIGN CORRELATION. Leichter, H.; Robinson, E. (California Univ., Livermore. Lawrence Radiation Lab.). Aug. 26, 1968. 55p. (CONF-690512-1). Dep. CFSTI.

From 71st Annual Meeting of the American Ceramic Society, Washington, D. C.

The fatigue behavior of a high-density graphite was investigated in reverse bending up to 5×10^5 cycles at room temperature. A statistical analysis was made of fatigue life, using a Weibull distribution and a homologous stress. The homologous stress is the ratio of applied stress in fatigue to the expected first-cycle strength. The first-cycle strength was calculated from the bending tests of similar material or "mate" specimens, using the Weibull statistical strength theory for correction of the significant size effect. Homologous stress gives an essentially invariant fatigue correlation for many graphite grades and may be used for the estimation of fatigue life under a wide variety of operating conditions. The practical endurance limit for graphite was found to correspond to a homologous stress of about 47%. (auth)

27168 X-RAY MEASUREMENT OF STRAIN IN TaC DUE TO COMPOSITION GRADIENTS. Sjodahl, L. H. (General Electric Co., Cincinnati). Contract AT(40-1)-2847. J. Amer. Ceram. Soc., 52: 216-17(Apr. 21, 1969).

Heating TaC in atmospheres with carbon activities different from that of the specimen resulted in carbon concentration gradients. The relative magnitude and direction of strain due to composition gradients were determined for solid and powder specimens of TaC heated in hydrogen or hydrogen and methane or under vacuum in the presence of free graphite. This method of observing strain by x-ray analyses is based on the difference in strain between differently oriented crystallites of cubic symmetry and on variation in lattice parameters with stoichiometry in nonstoichiometric solids. (G.M.C.)

27169 TIME AND LENGTH CORRECTIONS IN THE ANALYSIS OF THE INITIAL STAGES OF DIFFUSION-CONTROLLED SINTERING. Lay, K. W.; Carter, R. E. (General Electric Research and Development Center, Schenectady, N. Y.). J. Amer. Ceram. Soc., 52: 189-91(Apr. 21, 1969).

All models of the initial stages of sintering assume instantaneous heating of the shrinkage specimens to the sintering temperature. However, the time to reach the sintering temperature and the accompanying shrinkage can seriously affect the apparent shrinkage-time dependence that is used to identify the shrinkage mechanism. The thermal expansion of unsintered compacts is shown to be identical with that calculated from published thermal expansion coefficients. The correct initial hot length of a shrinkage compact is therefore the cold length corrected for thermal expansion. The time to heat a shrinkage specimen was measured and is identical with both the calculated heating time and that determined by extrapolating a length vs. time plot to the initial hot length. The length and time corrections obtained from this extrapolation are compared with those obtained by the methods of Johnson and Cutler and of Anderson. (auth)

27170 HIGH-TEMPERATURE HEMISPHERICAL SPECTRAL EMITTANCE OF URANIUM OXIDES AT 0.65 AND 0.70 μm. Held, Peter C.; Wilder, D. R. (Ames Lab., Iowa). J. Amer. Ceram. Soc., 52: 182-6(Apr. 21, 1969).

Hemispherical spectral emittances were measured for uranium oxides. The compositions ranged from $UO_{1.85}$ to $UO_{2.29}$, the bulk densities from about 8 to more than 10.6 g/cm³, the apparent porosities from less than 0.5 to 91.0%, and the temperatures from about 450 to about 2400°K. The data were taken at wavelengths of 0.656 and 0.70 μm. The emittance is high in all cases (from about 0.70 to above 0.90) and increases with increasing wavelength. The emittance is not strongly sensitive to temperature, porosity, density, surface finish, or stoichiometry. The high emittance values are linked to the absorption edge observed for uranium oxides in the visible portion of the spectrum. (auth)

27171 THE INFLUENCE OF Al_2O_3 ON THE STABILIZATION OF ZrO BY Y_2O_3. Pal'guev, S. F.; Strekalovskii, V. N.; Stefanovich, D. S. (Inst. of Electrochemistry, Sverdlovsk, USSR). Dokl. Akad. Nauk SSSR 184: 1376-9(Feb. 21, 1969). (In Russian).

Tabulated data are presented on the phase composition of products of $ZrO_2-Y_2O_3-Al_2O_3$ at 20 to 1580°C. X-ray analysis revealed that initial specimens annealed at 2000°C became single-phase 0.9 ZrO_2-0.1 Y_2O_3 solid solution. In the specimens with additions of aluminum oxides, the intensity spectra became erratic. (R.V.J.)

27172 ELASTIC PROPERTIES OF POLYCRYSTALLINE TiB_2, ZrB_2, AND HfB_2 FROM ROOM TEMPERATURE TO 1300°K. Wiley, D. E.; Manning, W. R.; Hunter, O. Jr. (Ames Lab., Iowa). J. Less-Common Metals, 18: 149-57(June 1969).

The Young's, shear, and bulk moduli of polycrystalline TiB_2, ZrB_2, and HfB_2 were determined from 298 to 1300°K by the sonic resonance technique. All three of these moduli decreased by about 9% over the temperature range considered. The Young's and shear moduli were fitted to Wachtman's empirical equation. The theoretical Soga-Anderson equation was applied to the bulk modulus-temperature data and found to fit the data within 1% despite the variation of the Soga-Anderson constant, δ, with temperature. The Grüneisen constant, γ, was found to remain invariant with temperature while the Poisson's ratio increased with increasing temperature. Debye temperatures were computed from the measured Young's and shear moduli. (auth)

27173 PREPARATION AND PROPERTIES OF CRYSTALLINE AND AMORPHOUS VANADIUM PENTOXIDE. Kennedy, T. N.; Hakim, R.; Mackenzie, J. D. (Rensselaer Polytechnic Inst., Troy, N. Y.). Mater. Res. Bull., 2: 193-201(1967).

From International Conference on Characterization of Materials, University Park, Pa. See CONF-661126.

A technique has been developed for the preparation of single crystals of vanadium pentoxide having dimensions of 5 cm × 5 cm × 0.5 cm. Amorphous films of V_2O_5 have also been prepared by vapor deposition. The expansion coefficient, density and electrical resistivity of these phases have been measured. (auth)

27174 EFFECT OF MULTIAXIAL STRESSES ON THE FRACTURE STRENGTH OF SILICON CARBIDE. Priddle, E. K. (Central Electricity Generating Board, Berkeley, Eng.). J. Strain Anal., 4: 81-7(Apr. 1969).

The fracture behavior of silicon carbide tubular specimens under multi-axial stresses at room temperature is described. A method of obtaining combinations of stresses in the form of torsion, hoop, axial tension, and compression is described and failure envelopes for silicon carbide are determined from the data obtained. Failure theories are reviewed and the results show that the available theories are inadequate to describe both the tension-tension and tension-compression quadrants. For practical purposes a straight-line relation can be used joining axial and hoop tensile strengths, and the axial compression strength. (auth) (UK)

27175 HIGH-TEMPERATURE STABILITY OF THORIA-STRENGTHENED NICKEL–CHROMIUM ALLOYS. Raymond, L.; Neumann, I. P. (Aerospace Corp., El Segundo, Calif.). Int. J. Powder Met., 5: No. 2, 97-104(Apr. 1969).

Two nickel-base, 20% chromium-2% thoria alloys, manufactured by different techniques, were studied with regard to their response to high-temperature exposure. Both alloys retained their dislocation substructure after 1 hr annealing treatments up to 1800°F. Annealing above this temperature resulted in a decrease in room temperature hardness of one of the alloys, while the other retained its original hardness and remained microstructurally stable up to 2400°F. The decrease in hardness at elevated temperature was associated with a decrease in the dislocation density and an increase in grain size. The thoria particles in the stable alloy had an average diameter of 550 Å, as compared to 820 Å for less stable alloy. It appears that the difference in the particle sizes accounts for the difference in structural stability at elevated temperatures. (auth)

27176 KNUDSEN CELL STUDIES OF THE VAPORIZATION OF SAMARIUM DICARBIDE. Stout, Norman D. (Univ. of California, Livermore); Hoenig, Clarence L.; Nordine, Paul C. J. Amer. Ceram. Soc., 52: 145-51(Mar. 1969).

The vapor pressure of SmC_2 in equilibrium with graphite was measured by the Knudsen effusion technique. Rates of weight loss from the cells were measured with an automatic recording balance. The apparent pressures varied with orifice size, and equilibrium pressures were calculated by extrapolation to zero orifice area. This work was combined with other studies to obtain $\log_{10}P(\text{atm}) = -13.869 \times 10^3/T + 3.752$ (1300–2050°K) for the Sm vapor pressure above SmC_2-C. Estimates of S^0_{298} and C_p were made for SmC_2, and ΔH^0_{298} was calculated to be 72.0 ± 2 kcal/mol for the reaction $SmC_2(s) \rightarrow Sm(g) + 2C(s)$. This value combined with $\Delta H^0_{v,298} = 48.6$ kcal/mol for Sm gives a $\Delta H^0_{f,298}$ for SmC_2 of -23.4 ± 2 kcal/mol. (auth)

27177 INVESTIGATION OF CARBON DIFFUSION FROM URANIUM MONOCARBIDE INTO MOLYBDENUM AND TUNGSTEN. Eremeev, V. S. At. Energ. (USSR), 25: 489-93(1968). (In Russian).

An approximate solution to the problem of UC interactions with Mo and W during diffusion is reported. The thicknesses of carbide layers forming on Mo and W owing to the carbon diffusion from UC at 1000 to 1800°C are calculated. Calculated values are in satisfactory agreement with values determined experimentally. The formula deduced permits determination of the time at which a liquid phase appears on the metal due to temperature instability. When UC containing 4.8 wt % C is used, the liquid phase on Mo is formed at 1700 to 1800°C in 80 to 160 hr. (auth)

27178 SURFACE STUDY OF BORON CARBIDE CRYSTALS, GROWTH, AND SCREW DISLOCATIONS. Zberea, I.; Constantinescu, F. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys., 13: 817-22(Oct. 1968).

The surface structure of boron carbide crystals was studied by electron diffraction, optical and interferometric techniques. The multiple-beam interference technique provided information related to the two-dimensional nucleation and crystalline growth at screw-dislocations of large Burgers vector. The heights of the spiral growth steps are given. The analogies between these structure aspects and those of silicon carbide crystallization are discussed. (auth)

27179 TRANSPARENT ZIRCONIA COMPOSITION AND PROCESS FOR MAKING SAME. Mazdiyasni, Khodabakhsh S.; Lynch, Charles; Smith II, Jonathan S. (to Secretary of the Air Force). U. S. Patent 3,432,314. Mar. 11, 1969. Filed Aug. 2, 1966.

A high density polycrystalline zirconium dioxide body is described which is stable at >2000°C. It consists of ZrO_2 containing ≈6 mole % of Y_2O_3, Dy_2O_3, or Yb_2O_3 as stabilizer. The ZrO_2 and selected additives are calcined in powder form, then pressed at 50,000 to 200,000 psi into shapes then sintered at 1450°C for 16 hrs. (J.R.D.)

27180 EVAPORATION OF HYPOSTOICHIOMETRIC PLUTONIUM DIOXIDE FROM 2070^0 TO 2380^{0}K. Messier, Donald R. (Argonne National Lab., Ill.). J. Amer. Ceram. Soc., 51: 710-13(Dec. 21, 1968).

Total vapor pressures of PuO_{2-x} compositions were measured gravimetrically with tungsten Knudsen cells from 2070 to 2380°K. The vapor pressure equation for the composition approximating the congruent one, $PuO_{1.82}$, is $\log P_e\,(\text{atm}) = 8.38\ (\pm 0.11) - [30.97\ (\pm 0.25) \times 10^3]/T$ where P_e is the pressure if the vapor is assumed to be entirely $PuO_2(g)$. The evaporation of $PuO_{1.56}$ was univariant, indicating the presence of two condensed phases, and that of $PuO_{1.62}$ was bivariant from 2240 to 2380°K; this result confirms that the phase boundary of the PuO_{2-x} phase remains at $PuO_{1.61}$ at temperatures close to the liquidus. (auth)

27181 STABILITY OF REFRACTORY MATERIALS IN VACUUM. Bonar, K. Mark; Cunningham, Jack L.; Walther, Frank H. Ind. Heat., 35: 2222; 2224; 2226; 2236(Nov. 1968).

Data are needed on behavior of refractories in vacuum metallurgical processes. Weight loss data and composition have been measured for several refractories after heating in vacuum to 3000°F in an induction furnace. Materials studied include basic brick, bonded and fusion cast; high alumina brick, bonded and fusion cast; and brick made of zircon and stabilized zirconia. Weight loss results for the higher purity single oxide refractories, MgO, CaO, ZrO_2 and Al_2O_3, compare favorably with published data. Zirconia and high alumina materials generally show lower weight loss than the basic oxides. In the basic refractories, the order of increasing stability of the volatile components is iron oxide, silica, magnesia and chromic oxide. All magnesium-chrome brick shows an increase in porosity after testing. In the burned high alumina group, the order of increasing stability of the oxides is iron oxide, silica and titania, with alumina having highest stability. Zircon and β alumina dissociated to the component oxides under these test conditions. (Metals Abstr.)

27182 THE [RESISTANCE OF] BORIDES IN MOLTEN METAL MEDIA. Hoch, Petr; Hoffmann, Josef. Hutn. Listy, 23: 848-59(Dec. 1968). (In Czech).

Temperatures and other data on the refractory and high-melting borides in metallurgical baths were analyzed. The basic characteristics (structure, electrical, chemical, and mechanical properties) of ZrB_2 and TiB_2 are given in detail. The thermal inertias of Pt/Pt–Rh thermometers sheathed in ZrB_2 and quartz were compared. At 1380°C the ZrB_2 system has less thermal inertia than the quartz system. These results can be applied in other cases. The borides are recommended for use in automated processes for continuous casting. 22 references. (Metals Abstr.)

27183 ROLE OF CRYSTALLINITY IN THE SINTERING OF URANIA POWDERS. Moorthy, V. K.; Rao, S. V. K. (Bhabha Atomic Research Centre, Bombay). Trans. Indian Ceram. Soc., 27: 16-30(1968).

The crystallinity in UO_2 powders prepared by the ADU route calcined at 600 to 1600°C and its influence on their sintering behavior at 1000 to 1600°C in hydrogen were studied by x-ray diffraction techniques. Powder patterns were made for the loose powders and back reflection for the sintered pellets. It was noticed that the higher the calcination temperature, the greater was the degree of crystallinity developed in the powders and poorer was their sinterability. The crystallinity of the sintered pellets was mainly dependent on the sintering temperature and crystallinity of the original powder and is not directly related to the sintered density. By sintering pellets of poorly crystalline powders at about 1200°C sintered pellets of near theoretical density but with poorly developed crystallinity could be obtained. (auth)

Structure and Phase Studies

Refer also to abstracts 27144, 27150, 27177, 27178, and 27202.

27184 (AERE-R-5922) PLUTONIUM–URANIUM–CARBON SYSTEM. Potter, P. E. (Atomic Energy Research Establishment, Harwell (England)). Oct. 1968. 40p. (CONF-680924-3). Dep. CFSTI. UK 5s. 6d.

From Panel on Plutonium Utilization, Vienna, Austria.

Studies on the phase relationships and thermodynamic properties of the plutonium-uranium-carbon ternary system are reviewed and areas for future work defined. The main features of the system are that there are no ternary compounds and that there are regions of complete miscibility between uranium and plutonium monocarbides and also between the sesquicarbides. (auth) (UK)

27185 (AERE-R-6000) ATOMIC VIBRATIONS IN CARBON FIBRES. Collins, M. F.; Haywood, B. C. (Atomic Energy Research Establishment, Harwell (England)). Jan. 1969. 8p. Dep. CFSTI. UK 1s. 9d.

Longitudinal lattice vibrations with wavelengths between 7 and 30 Å were observed along the crystallographic c-axis in carbon fibers by the method of neutron spectrometry. The vibrations propagate for at least 150 Å and have frequencies 15% less than those found in pyrolytic graphite. Measurements of the 0002 Bragg peak indicated crystal sizes along the c-axis of order 200 Å, with a lattice spacing 6.82 ± 0.02 Å, compared with the lattice spacing of 6.71 Å in normal graphite, and 6.88 Å in turbostatic graphite. (auth) (UK)

27186 DEFECT STRUCTURE OF Y_2O_3–ZrO_2 SOLID SOLUTIONS. Bratton, R. J. (Westinghouse Electric Corp., Pittsburgh). J. Amer. Ceram. Soc., 52: 213(Apr. 21, 1969).

Structural defect models for $Y_2O_3-ZrO_2$ solid solutions were considered. An oxygen interstitial model was selected on the basis of known lattice parameters and calculated and measured densities of Y_2O_3 solid solutions. (G.M.C.)

27187 REACTIONS IN THE SYSTEM ZrO_2–SrO. Noguchi, Tetsuo; Okubo, Tsutomu; Yonemochi, Osam (Government Industrial Research Inst., Nagoya, Japan). J. Amer. Ceram. Soc., 52: 178-81(Apr. 21, 1969).

The liquidus curve of the system ZrO_2–SrO was investigated with a heliostat-type solar furnace. The cooling curve of a specimen was obtained with a brightness pyrometer at 0.65 μm to determine the freezing point and other transition phenomena. The primary phases and the compounds formed in the system were also examined. The existence of $Sr_nZr_{n-1}O_{3n-2}$ (n = 4, 3, and 2) and of $SrZrO_3$ was confirmed. A tentative phase diagram of the system ZrO_2–SrO at high temperatures is presented. (auth)

27188 PRECISE DETERMINATION OF THE LATTICE PARAMETERS OF HOLMIUM AND ERBIUM SESQUIOXIDES AT ELEVATED TEMPERATURES. Singh, H. P.; Dayal, B. (Banaras Hindu Univ., India). J. Less-Common Metals, 18: 172-4(June 1969).

At high temperatures, erbium and holmium sesquioxide are body-centered cubic with the thallium oxide type structure and with sixteen molecules per unit cell. Precise values for the lattice parameters and thermal expansion of holmium sesquioxide at 23 to 737°C are reported. The values of the lattice parameters and thermal expansion of erbium sesquioxide are also given. (G.M.C.)

27189 SUPERPLASTICITY IN PURE ZrO_2. Hart, J. L.; Chaklader, A C. D. (Univ. of British Columbia, Vancouver). Mater. Res. Bull., 2: 521-6(1967).

From International Conference on Characterization of Materials, University Park, Pa. See CONF-661126.

Superplasticity or enhanced plasticity during the monoclinic ⇌ tetragonal transformation of pure dense zirconia has been studied. The total strain that can be produced was found to depend on the density of the materials. From this point of view, the superplasticity in this case differs from other known superplastic behavior. (auth)

27190 POLYMORPHISM OF $BaTa_2O_6$. Layden, G. K. (United Aircraft Research Labs., East Hartford, Conn.). Mater. Res. Bull., 2: 533-9(1967).

From International Conference on Characterization of Materials, University Park, Pa. See CONF-661126.

Phase studies in the system $BaB_2O_4-BaTa_2O_6$ disclosed three modifications of the latter compound: a low temperature modification isomorphous with orthorhombic $BaNb_2O_6$ which forms below about 1150°C, a tetragonal modification having the potassium tungsten bronze structure which forms between about 1150 and 1300°C, and a hexagonal modification stable from 1300°C to its melting point at about 1850 to 1900°C. Crystals of the orthorhombic and hexagonal modifications have been grown from this system by the slow-cooling technique. The tetragonal form could only be obtained as a very fine precipitate. Attempts were made to grow the hexagonal modification from the melt using the Czochralski technique. It was found that not only the hexagonal, but the orthorhombic and tetragonal forms as well, could be grown in this fashion. The phase transformation of crystal fragments was investigated. Only transformations from the orthorhombic and tetragonal forms to the hexagonal form were observed to occur in times less than 100 hours in the appropriate temperature ranges. (auth)

27191 MAGNETIC AND STRUCTURAL STUDY OF THE SPINEL $MnYb_2S_4$. Longo, J. M.; Raccah, P. M. (Massachusetts Inst. of Tech., Cambridge). Mater. Res. Bull., 2: 541-7 (1967).

From International Conference on Characterization of Materials, University Park, Pa. See CONF-661126.

The compound $MnYb_2S_4$ has the normal spinel structure with no measurable mixing of atoms in octahedral and tetrahedral sites. The sulfur parameter is 0.380 ± 0.002, which is lower than usually found in spinels. Magnetic susceptibility shows no magnetic order to liquid He temperature and a temperature dependence that is the simple sum of the theoretical contributions for Yb^{3+} and Mn^{2+} ions. (auth)

27192 NONSTOICHIOMETRY AND INTERFACIAL DISLOCATIONS IN TUNGSTEN TRIOXIDE. Spyridelis, J.; Delavignette, P.; Amelinckx, S. (SCK–CEN, Mol, Belgium). Mater. Res. Bull., 2: 615-20(1967).

From International Conference on Characterization of Materials, University Park, Pa. See CONF-661126.

Electron microscopic evidence is presented for the presence of interfacial dislocations between tungsten trioxide single crystal layers of different stoichiometric composition. It is shown that the regular arrangement of dislocations gives rise to a grating which causes a diffraction effect which is easily observable in electron diffraction. The dislocation spacing corresponds with the observed long spacing in the diffraction pattern. (auth)

27193 PREPARATION AND PROPERTIES OF RARE-EARTH SILICATES AND ALUMINATES. Bondar, I. A.; Toropov, N. A. (Inst. of Silicate Chemistry, Leningrad). Mater. Res. Bull., 2: 479-89(1967).

From International Conference on Characterization of Materials, University Park, Pa. See CONF-661126.

Three families of compounds between trivalent rare-earths and silica have been established; the compounds fall into three structural sub-groups. Phase equilibria of rare-earth silicates and aluminates have been investigated. Single crystals of some rare-earth silicates and aluminates have been obtained. The possibilities of applications of materials based on rare-earth silicates and aluminates have been considered and the process of dispersion hardening has been examined. (auth)

27194 THE ELECTRICAL PROPERTIES AND BAND STRUCTURE OF DOPED $LaInO_3$. Rogers, D. B.; Honig, J. M.; Goodenough, J. B. (Massachusetts Inst. of Tech., Cambridge). Mater. Res. Bull., 2: 223-30(1967).

From International Conference on Characterization of Materials, University Park, Pa. See CONF-661126.

Theoretical arguments suggest that $LaInO_3$ might be a narrow-band semiconductor rather than an ionic insulator. Experimental measurements of resistivity show that at lower temperatures the doped material behaves like a p-type extrinsic semiconductor, and at higher temperatures, like an intrinsic material with a gap energy of 2.2 eV. The Seebeck coefficient changes from positive to negative values with rising temperature slightly above the range of temperature in which the system shifts from the extrinsic to the intrinsic regime. These findings are interpreted in terms of an elementary band model. (auth)

27195 COMPOSITION DEPENDENT ORDER-DISORDER PHENOMENA IN $CoNb_{2-x}Ta_xO_6$ AND $NiNb_{2-x}Ta_xO_6$. Felten, Edward J. (Pratt and Whitney Aircraft, North Haven, Conn.). Mater. Res. Bull., 2: 13-24(1967).

From International Conference on Characterization of Materials, University Park, Pa. See CONF-661126.

Mixed oxides in the pseudo-binary systems $CoNb_2O_6-CoTa_2O_6$, $NiNb_2O_6-NiTa_2O_6$, and $MgNb_2O_6-MgTa_2O_6$ were examined after quenching from 1400°C or from the melt for compositional-dependent order-disorder effects. In the cobalt and nickel systems transformation from the disordered niobate to the ordered tantalate is observed. Ordering is manifested by the appearance of weak, broad superlattice reflections in oxides of high niobium content. Increasing the tantalum content produces more intense and sharper superlattice reflections. These effects are absent in the magnesium. (auth)

27196 $EuCl_3$-$6H_2O$-BASE SOLID SOLUTIONS OF RARE-EARTH ELEMENT CHLORIDES. Nikolaev, A. V.; Sorokina, A. A.; Vilenskaya, A. J. (Inst. of Inorganic Chemistry, Novosibirsk, USSR). Dokl. Akad. Nauk SSSR, 185: 608-9(Mar. 21, 1969). (In Russian).

Seven systems of rare earths with $EuCl_3 \cdot 6H_2O$ base were studied. Two-valence europium was determined. Phase diagrams are given for $EuCl_3 - LaCl_3 \cdot H_2O$, $EuCl_3 - PrCl_3 \cdot H_2O$, $EuCl_3 - NdCl_3 \cdot H_2O$, $EuCl_3 - SmCl_3 \cdot H_2O$, $EuCl_3 - GdCl_3 \cdot H_2O$, $EuCl_3 - YCl_3 \cdot H_2O$ and $EuCl_3 - YbC_3 \cdot H_2O$. (R.V.J.)

27197 PHASE EQUILIBRIA IN THE $NaNbO_3$–$BaNb_2O_6$ SYSTEM. Scott, B. A.; Giess, E. A.; O'Kane, D. F. (IBM Watson Research Center, Yorktown Heights, N. Y.). Mater. Res. Bull., 4: 107-18(Feb. 1969).

Complete liquidus and solidus equilibria have been established by DTA and quench techniques in the system $NaNbO_3 - BaNb_2O_6$, which contains the pseudo-tetragonal bronze $NaBa_2Nb_5O_{15}$. While little solid solution occurs in the end member compounds, the tungsten bronze phase shows extensive solid solubility from 62 to 83 mole % $BaNb_2O_6$. These results and subsolidus DTA and dielectric measurements are discussed in relation to the crystal chemistry of the bronze structure. The essential features of the phase diagram have been confirmed by Czochralski crystal growth experiments at selected melt compositions in the bronze(ss) field. (auth)

27198 SUBSOLIDUS STABILITY RELATIONS IN THE SYSTEM $KTaO_3$–$KNbO_3$. Hill, V. G.; Chang, L. L. Y.; Harker, R. I. (Tem-Pres Research, Inc., State College, Pa.). J. Amer. Ceram. Soc., 51: 723-4(Dec. 21, 1968).

Methods used to grow single crystals of $KNbO_3$ and $KTaO_3$ are described. Subsolidus phase relations in the system $KNbO_3 - KTaO_3$, based on experimental data are shown. X-ray diffraction patterns from crystals of $KTaO_3$ and $KNbO_3$ were found to be very similar. (P.G.C.)

27199 NEUTRON-DIFFRACTION STUDY OF THE STRUCTURE AND PHASE TRANSFORMATIONS OF TANTALUM HYDRIDES AND DEUTERIDES. Somenkov, V. A.; Gurskaya, A. V.; Zemlyanov, M. G.; Kost, M. E.; Chernoplekov, N. A.; Chertkov, A. A. Sov. Phys.-Solid State (Engl. Transl.), 10: 2123-7(Mar. 1969).

Translated from Fiz. Tverd. Tela, 10: 2697-2703(Sept. 1968).

Tantalum hydrides and deuterides with compositions close to equiatomic ratio were studied by neutron diffraction and thermographic analysis. Phase transformations associated with the ordering of the light atoms were established in these systems, and the structures of the low- and high-temperature phases were determined. These structures were analogous to those of the corresponding phases in the niobium–hydrogen system. A model of the structure associated with the composition Ta_2D is proposed on the basis of Wallace's experimental data. (auth)

Radiation Effects

Refer also to abstracts 28486–28488.

27200 (EURAEC-2091) STUDY OF FISSION GAS RELEASE FROM UO_2 SAMPLES IRRADIATED UP TO VARIOUS DOSES. Final Report, November 1, 1965–April 30, 1968. Baffigo, V.; Giarda, L.; Frigerio, G.; Polin, F. (Societa Ricerche Impianti Nucleari, Saluggia (Italy). Centro Ricerche Nucleari). Nov. 1968. Contract 043-65-TEEI(RD). 26p. (EUR-4011). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

The dependence on radiation dose of the D′ (1400°C) coefficient of ^{133}Xe diffusion in UO_2, as measured in post-irradiation annealing experiments, was studied. The measurements have been performed on UO_2 pellets, irradiated with doses from a few MWd/t to ~8,000 MWd/t and on fused UO_2 samples of four different origins, irradiated with doses from a few MWd/t to ~2,000 MWd/t. The dose effect on the release rate parameter of ^{133}Xe, consisting of a decrease in D′ with increasing radiation dose, appears to occur in fused UO_2 mostly during the first 100 MWd/t and is about 2 orders of magnitude. Both on fused UO_2 powders and grains an increase in D′, subsequent to a maximum in its initial decrease, was observed. This increase seems effective after a few hundreds MWd/t and brings the D′ values almost to their initial levels at about 2000 MWd/t. The high-density powders from four different origins (0.3 to 0.5 mm fractions) furnished D′ values approximately 2 orders of magnitude higher than corresponding values of high density grains (3 to 5 mm fractions). As a consequence of their lower density, hot pressed UO_2 samples have release rates higher than those of fused UO_2 samples. On the other hand, for fused UO_2 specimens systematic differences were observed in different types made with different fabrication processes. In UO_2 pellets the radiation dose effect on D′ values for ^{133}Xe was evaluated in 3 to 4 orders of magnitude going from a few MWd/t to a few thousands MWd/t. This was found to hold both for pellets of 92 and 95% theoretical density. In more dense pellets the D′ coefficient increases after reaching a minimum at the saturation level. This does not occur for less dense pellets whose D′ decreases and reaches a saturation level without further increase at least within ~8,000 MWd/t. These results seem to confirm the necessity of using in power reactors UO_2 pellets of not too high density. (auth)

27201 (N-69-10216) ESTIMATION OF FISSION-PRODUCT GAS PRESSURE IN URANIUM DIOXIDE CERAMIC FUEL ELEMENTS. Paulson, Walter A.; Springborn, Roy H. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Nov. 1968. 32p. (NASA-TN-D-4823). CFSTI.

Fission-product gas pressure in macroscopic voids was calculated at 1000 to 2500°K for clad uranium dioxide fuel elements operating in a fast neutron spectrum. The calculated fission-product yields for uranium-233 and uranium-235 used in the pressure calculations were based on experimental data compiled from various sources. The contributions of cesium, rubidium, and other condensable fission products are included with those of the gases xenon and krypton. At low temperatures, xenon and krypton are the major contributors to the total pressure. At high temperatures, however, cesium and rubidium can make a contribution to the total pressure. (auth) (STAR)

27202 (SRARI-P-29) ON THE QUESTION OF THE DISTRIBUTION OF FISSION FRAGMENTS IN A LATTICE OF URANIUM DIOXIDE. Vyskubov, V. P.; Pebedev, I. G. (Scientific Research Atomic Reactor Inst., Melekess (USSR)). 1968. 14p. (In Russian). Dep.

UO_2 crystal lattice states after the high temperature irradiation to burnup of 9 at. % U were investigated by x-ray analysis. The structural factor values have been calculated in relative units and the relationships have been plotted in terms of sine ($|F(hkl)|^2$-curves. It is proved from the mutual $|F(hkl)|^2$ curves position that the fission fragments occupy the octahedral pores of UO_2 lattice. The supposition has been made that the observed UO_2 lattice period decrease is associated with both the fission fragment accumulation in it and additional oxidation. (auth)

27203 NEW CERAMIC MATERIAL FOR THE MEASUREMENT OF NUCLEAR RADIATION AND ITS APPLICATION IN CIVIL DEFENSE. Carpentier, S.; Delarue, R. Ind. Ceram., No. 608, 499(1968). (In French).

The French Atomic Energy Commission has developed a 96%-Al_2O_3 ceramic treated so that it becomes radio-thermoluminescent when exposed to nuclear radiation. The treatment is not stated. (Brit. Ceram. Abstr.)

27204 AN EXTRAPOLATED EQUATION OF STATE FOR XENON FOR USE IN FUEL SWELLING CALCULATIONS. Harrison, J. W. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Mater., 31: 99-106(1969).

An extrapolation is made of the existing argon equation of state to higher pressures and temperatures. Because there is good experimental evidence that the theorem of corresponding states is obeyed for argon and xenon over the range of existing experimental measurements, the extrapolated argon equation may be used for xenon with suitable scaling. Examples are given of the use of the new xenon equation of state in the calculation of gas contents of bubbles and uranium carbide swelling and compared with similar calculations using the modified van der Waals' law showing how the latter underestimates the gas content of bubbles and overestimates gas swelling. (auth)

27205 ANNEALING OF IRRADIATION–INDUCED THERMAL CONDUCTIVITY CHANGES IN ThO_2–1.3 WT. PERCENT UO_2. MacEwan, J. R.; Stoute, R. L. (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Amer. Ceram. Soc., 52: 160-5(Mar. 1969).

The thermal conductivities of sintered pellets of $ThO_2 - 1.3$ wt % UO_2 were measured at 60°C before and after irradiation. The irradiation temperature was below 156°C, and the exposures varied from 3.1×10^{14} to 4.7×10^{17} fissions/cm^3. Each fission fragment damaged a region of 2.2×10^{-16} cm^3 with the reduction in conductivity saturating by about 10^{17} fissions/cm^3. Samples having exposures from 10^{15} to 10^{16} fissions/cm^3 were annealed isothermally at 651°C or isochronally from 300 to 1200°C to study the annealing of damage. Most of the annealing occurred between 500 and 900°C. The width of this interval plus the slow isothermal annealing suggest that the damage is annealed by a number of single order processes with a spectrum of activation energies from 1.8 to 3.9 eV or, less probably, by a high order process with an activation energy of 3.55 ± 0.4 eV. (auth)

Plastics and Other Materials

Refer also to abstracts 26354, 27157, 28460, 28486, 28492, and 28630.

27206 (AWRE-O-81/68) FILAMENT WINDING. A CRITICAL SURVEY OF MATERIALS, PROCESSES, AND APPLICATIONS. Newling, D. O. (Atomic Weapons Research Establishment, Aldermaston (England)). Dec. 1968. 112p. Dep. CFSTI. UK 15s.

The development of the technique of producing filament wound reinforced plastics is described. The materials used are described, and a glossary of terms included. (auth) (UK)

27207 (BNWL-tr-27) GASIFICATION OF REACTOR GRAPHITE WITH CARBON DIOXIDE AND STEAM. Hedden, K.; Lowe, H. Translated by Diana L. Davis (Battelle-Northwest, Richland, Wash.), from Carbon, 5: 339-53(Sept. 1967). 24p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 22: 4920. (L.C.L.)

27208 (SC-RR-68-651) CHARACTERIZATION OF CARBON FABRICS AND FILAMENTS, CARBONIZING RESINS, CARBON–CARBON COMPOSITES, AND PROCESSING TECHNIQUES. Mackay, H. A. (Sandia Labs., Albuquerque, N. Mex.). Apr. 1969. 30p. Dep. CFSTI.

The status of Sandia material developments on carbonizing resins, carbon fabrics and yarns, carbon composites, and processing parameters is reviewed. The properties of the carbon–carbon composite laminate are dependent on the type, composition, and orientation of the carbon or graphite reinforcement; the initial carbonizing resin binder; and certain processing parameters. The resin char yield after carbonization ranges from 15 to 85 percent; the phenolics and epoxylated novolacs provide 60-percent residual carbon. Carbon and graphite fabrics or yarns with no previous history of phosphorus flame retardant additives are recommended as reinforcements because they maintain fiber identity in the composite after carbonization. When carbonized at 1550°F, carbon–carbon laminates composed of a 60-percent carbon char forming resin and a square weave 99 percent carbon fabric show weight losses of 16 to 20 percent. After three reimpregnations with oxalic acid catalyzed furfuryl alcohol and three recarbonization cycles, these laminates retain 60 to 100 percent of noncarbonized control mechanical property values from 75 to 900°F. (auth)

PHYSICS (GENERAL)

Astrophysics and Cosmology

27209 (AD–680415) RESEARCH IN ASTROPHYSICS. Final Report, July 1964–September 1968. Goldstein, Jack S. (Brandeis Univ., Waltham, Mass. Dept. of Physics). Oct. 1968. Contract AF19(628)-4019. 13p. (AFCRL–68-0584). CFSTI.

A summary is given of work accomplished in five general categories: (1) The fluid motions of planetary nebulae including radiative transfer aspects of the problem. (2) The evaporation of stars from clusters, and their dynamical history, including the problem of secular stability of such systems. (3) Problems of gravitational instability and condensation of stellar systems. (4) Properties of waves in dense plasmas, including the effects of screening by degenerate electrons on the rates of possible nuclear reactions. (5) Properties of shock waves in attenuated media, especially in attenuated plasmas. Subsidiary related work is also reported. A full bibliography of this work is included. In addition, unpublished work is described in the following subjects: (a) A variational principle for the stability of star clusters. (b) The electrodynamics and statistical mechanics of equilibrium plasmas. (c) The transport properties of magnetoplasmas. (auth) (USGRDR)

Cosmic Ray Exposure Ages

27210 ON THE STUDY OF COSMIC DUST. 4. COSMIC DUST IN ATMOSPHERE. Yabuki, Hideo; Okada, Akihiko (Inst. of Physical and Chemical Research, Yamato, Japan). Rikagaku Kenkyusho Hokoku, 45: 10-17(Jan. 1969). (In Japanese).

Cosmic dust is thought to be a material that gives information about the formation of the Universe. To avoid any terrestrial contamination, the dust particles were collected by an airplane or a balloon at high altitude (10 ~ 20 km), where the density of terrestrial dust was considered very low. A dust detector with a piezoelectric microphone was made and flown on a rocket at a height of about 100 km. After the recovery the cosmic dust was studied for physical (size, density, etc.) and mineralogical properties and for the chemical composition. These dust particles were similar to materials which had been collected on the surface of the Earth, on the bottom of the Pacific Ocean, and also in the ice of Antarctica. An attempt was made to extract nuclides such as ^{59}Ni, ^{56}Co, ^{53}Mn, ^{26}Al, ^{10}Be, etc., which are produced by cosmic rays or solar protons, from these samples. (auth)

Stars

Refer also to abstract 27262.

27211 (AD–679178) OPTICAL STUDIES OF FLARE STARS IN CONJUNCTION WITH SIMULTANEOUS RADIO FREQUENCY OBSERVATIONS OF THE SAME STARS. Final Report, September 1, 1966–August 31, 1968. Report No. 811-40. Martin, Robert W. (Smithsonian Astrophysical Observatory, Cambridge, Mass.). Nov. 1968. Contract N00014-67-C-0161. 16p. CFSTI.

This paper gives optical data, taken in a one-year program of flare-star photography in conjunction with radio-frequency observations by cooperating universities. The data are reduced to light curves for meaningful comparison and analysis with radio data. (USGRDR)

27212 (N–69-15385) AN ANALYSIS OF THE PECULIAR A STAR HD204411. Sargent, W. L. W.; Strom, K. M.; Strom, S. E. (Smithsonian Astrophysical Observatory, Cambridge, Mass.). Dec. 1968. 28p. (NASA-CR–99083). CFSTI.

Well-widened, high-dispersion spectra were used to obtain the identifications and equivalent widths for over 1500 lines between 3700 and 4900 Å for the relatively cool Ap star, HD 204411. A model atmosphere analysis of these data was performed. The large number of lines used allowed a discussion and ruling out of any significant departures from LTE in the level populations for the lines, or any large variation of the turbulent velocity parameter with height. The results suggest a broadening of the Fe peak abundances, an overall enhancement of the Fe peak relative to H, and a decrease in the ratio of light element abundances to iron. The evidence also indicates that the s-process elements Sr and Zr have normal abundances relative to Fe. (auth) (STAR)

27213 RESEARCH ON VARIABLE STARS. Wenzel, Wolfgang. Jena Rev., No. 6, 330-3(1968).

The types of variability and the statistics of variable stars are outlined. The physical processes responsible for the variability are discussed. Some of the instruments used in research on variable stars are illustrated. (W.D.M.)

27214 OBSERVATION OF THE NOVA DELPHINI 1967 WITH THE 2 METRE-UNIVERSAL REFLECTING TELESCOPE. Bartl, Erich (Karl-Schwarzschild Observatory, Tautenburg, Ger.). Jena Rev., No. 6, 334-6(1968).

Nova Delphini 1967 was included in the test program of the Cassegrain spectrograph on the 2-meter Universal Reflecting Telescope and was subsequently observed during the two periods July 27 to Aug. 13, 1967 and March 20 to May 11, 1968. The results are briefly summarized. (W.D.M.)

27215 DETERMINATION OF ABSOLUTE SPECTROPHOTOMETRIC GRADIENTS OF 10 ECLIPSED BINARY STARS. Azimov, S. M. Izv. Akad. Nauk Azerb. SSR, Ser. Fiz.-Tekh. Mat. Nauk, No. 3, 75-8(1968). (In Russian).

The absolute spectrophotometric gradients of the eclipsed binary systems RS Ari, RSCVn, S Cnc, SX Cas, GG Cas, U Cep, AR Lac, UX Mon, RY Per, and U Sge were determined for the spectral range of $\lambda = 4600$ to 3790 Å. The satellites of these stars and in some cases the main stars themselves are subgiants. The observations were made during the winter of 1964 at the Abastuman Astrophysical Observatory of the Georgian Academy of Sciences with unsensitized Kodak OaO and Agfa Astro films. The spectrograms were handled on an automatic recording microphotometer; the spectra of the main stars were taken with a sector diaphragm. From the relative gradients of the stars used for comparison, the absolute values were calculated and were presented in tabular form. It was attempted to evaluate the absorption of light in the interstellar space but fluctuations of the interstellar medium rendered the values obtained unreliable. The data obtained were used to calculate the spectrophotometric temperature of the above eclipsed binary stars for $\lambda = 4000$ Å. (TTT)

27216 THE CENTER OF ACTIVITY IN THE CRAB NEBULA. Scargle, J. D. (Univ. of California, Santa Cruz). Astrophys. Lett., 3: 73-6(Mar. 1969).

The continuously and rapidly changing features near the middle of the Crab Nebula have recently assumed a symmetrical configuration which precisely defines a center. This point of symmetry is probably connected with the generator of the activity, and is possibly identifiable with the other singular aspects of the nebula. (auth)

27217 CALCULATION OF A WHITE DWARF SUPERNOVA. Hansen, Carl J.; Wheeler, J. Craig (Joint Inst. for Lab. Astrophysics, Boulder, Colo.). Astrophys. Space Sci., 3: 464-74 (Mar. 1969).

A hydrodynamic calculation of a 1.42 $M_{\odot}$ white dwarf supernova is described. Instability and collapse are initiated by electron capture and the subsequent nuclear detonation of ^{12}C at high densities is sufficient to disperse all the material of the star with an average velocity of 700 km/sec and total energy of 8×10^{50} ergs. Some limitations on the generality of the results are discussed. (auth)

27218 DYNAMICAL MODELS OF NOVAE. Sparks, Warren M. (Indiana Univ., Bloomington. Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J., 156: 569-95(May 1969).

The dynamics of a nova outburst are studied by means of a time-dependent hydrodynamics computer program which includes transport of energy by radiation and convection. Two distinct types of ejections which could give rise to novae are identified. The "flash" nova (e.g., T CrB) has a very rapidly rising and falling light curve and a rapidly decreasing velocity curve. A strong shock wave which imparts a velocity greater than the escape velocity to the outer layers of the star will produce this behavior. A less rapidly rising and falling light curve and a nearly constant velocity are characteristic of the "ordinary" nova (e.g., GK Per). These features will result when the stellar material is forced outward by a pressure front which is not a shock wave. The premaximum halt, which is characteristic of the latter type of nova, results from the temperature dependence of the opacity of neutral hydrogen. (auth)

27219 THE BLUE HORIZONTAL-BRANCH STARS OF NGC 6397. Newell, E. B.; Rodgers, A. W.; Searle, Leonard (Australian National Univ., Canberra). Astrophys. J., 156: 597-608(May 1969).

From spectroscopic and narrow-band photoelectric observations the atmospheric parameters log g and θ_e for 19 blue horizontal-branch stars in the globular cluster NGC 6397 were derived. These data were combined with measurements of the cluster reddening and distance modulus to yield a mean mass $\langle M \rangle = 0.55 \pm 0.15\ M_\odot$ and a mean luminosity $\langle \log L/L_\odot \rangle = 1.64 \pm 0.1$. The blue horizontal-branch stars appear to occupy a wedge-shaped domain in the theoretical HR diagram. (auth)

27220 A SPECTROSCOPIC STUDY OF THE ASSOCIATION SCORPIUS OB 1. **Schild, Rudolph E. (Carnegie Inst. of Washington, D. C. California Inst. of Tech., Pasadena); Hiltner, W. A.; Sanduleak, N. Astrophys. J., 156: 609-15(May 1969).**

New spectral classifications and UBV photometry are reported for the southern association Sco OB 1 which contains the cluster NGC 6231. For an assumed ratio of total to selective absorption of 3.0, a distance of 2.0 kpc is derived. The H–R diagram shows a turnup at spectral type O9 – O9.5. NGC 6231 is younger than h Per, and an age of 5 million years is estimated from a comparison with stellar models. Two Wolf–Rayet stars, one WC7 and one WN7-A, have similar colors and luminosities. The colors and luminosities of the W–R continua are found to be like those of early B supergiants. Other stars of special interest are discussed. (auth)

27221 FAINT CEPHEIDS IN CYGNUS AND MONOCEROS. **Eggen, Olin J. (Australian National Univ., Canberra). Astrophys. J., 156: 617-28(May 1969).**

Photoelectric (UBV) photometry of eighteen faint Cepheids in Cygnus and ten in Monoceros is discussed. Observations of a few sequence stars near Nova Cyg 1948 are also given. (auth)

27222 THE SPECTRUM OF α^2 CANUM VENATICORUM, 5000 TO 6700 A. Cohen, Judith G.; Deutsch, Armin J.; Greenstein, Jesse L. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 156: 629-51(May 1969).

A complete list is given of all lines observed between 5000 and 6650 Å in the spectrum of α^2 CVn. Approximately three-quarters of the features were identified. Lines of Pb(II) and P(II) are not present. Lines of Gd(III) and Pr(III) vary in equivalent width and radial velocity in a manner similar to the singly ionized rare earths. Lines of Cl(II) are present and also behave like those of a rare earth. (auth)

27223 THE MAGNETIC FIELD AND LIGHT VARIATIONS OF 17 COMAE BERENICES AND κ CANCRI. Preston, George W. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena); Stepien, Kazimierz; Wolff, Sidney Carne. Astrophys. J., 156: 653-60(May 1969).

Concurrent series of Zeeman spectroscopic and UBV photometric observations are used to show that 17 Com exhibits periodic magnetic and light variations and, in addition, variations of small amplitude in the lines of Ti(II), Sr(II), and Eu(II). The light and the magnetic field of κ Cnc appear to vary periodically with a period of either 5.0035 or 6.91 days. The former period has been adopted provisionally as the more likely value on the basis of scatter in the resulting phase diagrams. (auth)

27224 ZEEMAN OBSERVATIONS OF METALLIC-LINE STARS. **Conti, Peter S. (Univ. of California, Santa Cruz). Astrophys. J., 156: 661-5(May 1969).**

In his classic study of stellar magnetic fields, Babcock listed six metallic-line (Am) stars as having fields of a few hundred gauss. Since that time, the impression has been given in the literature that magnetic fields of moderate intensity were, in fact, obiquitous among Am stars, and their similarities to Ap stars in this respect have been stressed. 16 Ori, the one Am star that Babcock found to have a field with reversing polarity (from two measured spectra) was studied extensively with the Zeeman analyzer of the 120-inch coudé. No field significantly larger than an internal probable error of about 50 gauss was found on any fifteen spectra taken of this star. Additionally, no fields were found in nine Zeeman spectra of 15 Vul, an Am star not studied by Babcock. These new measures, of the brightest and sharpest-lined Am stars, throw doubts on the presence of magnetic fields in Am stars. The radial-velocity measures, however, do show 16 Ori to be a spectroscopic binary. Elements of the orbit are given. On the other hand, the binary nature of 15 Vul is shown to be dubious. (auth)

27225 SPECTROGRAPHIC AND PHOTOMETRIC ANALYSES OF HR 7484. **Snowden, Michael S. (Kitt Peak National Observatory, Tucson, Ariz.); Koch, Robert H. Astrophys. J., 156: 667-80(May 1969).**

Spectrographic and photoelectric analyses of the F-type sharpline eclipsing binary, HR 7484, are reported. The orbital eccentricity is greater than 0.5, and several consequent methodological limitations and exploratory techniques are described. Accurate masses, radii, color indices, and absolute magnitudes are derived. (auth)

27226 NON-LTE MODEL ATMOSPHERES. II. EFFECTS OF BALMER α. Auer, L. H.; Mihalas, Dimitri (Joint Inst. for Lab. Astrophysics, Boulder, Colo.). Astrophys. J., 156: 681-6 (May 1969).

Four models of pure-hydrogen stellar atmospheres in radiative equilibrium with $T_{eff} = 15000$ and $\log g = 4$ are presented. Results are given for both the LTE and non-LTE cases, with and without the inclusion of Hα. The calculations show that (a) Hα causes a temperature rise, not a drop, at the surface, (b) the direct effect of cooling in the line is less important than the indirect effects of changing level populations, and (c) the Balmer and Paschen jumps are unaltered by non-LTE effects. (auth)

27227 MODEL ATMOSPHERES FOR O-TYPE STARS WITH ULTRAVIOLET LINE BLANKETING. **Bradley, Philip T.; Morton, Donald C. (Princeton Univ. Observatory, N. J.). Astrophys. J., 156: 687-94(May 1969).**

Six LTE model atmospheres were computed for surface gravities corresponding to $\log g = 3.5$ and 4.0 and for effective temperatures ranging from 28640 to 37450°K. The detailed bound–bound opacity of 110 far-ultraviolet lines was added to the continuous opacity of H(I), H^-, He(I), He(II), and free electrons. Fluxes are constant with depth to about 1%. Tables give the bolometric corrections, depth variations of temperature and pressure, and the spectral distributions of the emergent flux for the models. (auth)

27228 PULSATION HYPOTHESIS FOR MASSIVE RED SUPERGIANTS. **Stothers, Richard (Goddard Space Flight Center, New York). Astrophys. J., 156: 541-7(May 1969).**

The fundamental mode of radial pulsation was calculated for convective envelopes in adiabatic equilibrium including radiation pressure. The theoretical Q-values are compared with the observational Q values of variable M supergiants in galactic associations. The variability of these massive red supergiants can be explained on the pulsation hypothesis if a suitable readjustment of some of the observed periods is made. Pulsation seems to be suggested by (1) the cyclical variations in magnitude, spectrum, and radius in individual stars, (2) a period–luminosity relation, and (3) a period–spectrum relation for the group of stars. (auth)

27229 STUDIES IN STELLAR EVOLUTION. VIII. THE TIME SCALE FOR THE DIFFUSION OF ENERGY IN THE STELLAR INTERIOR. **Henyey, Louis; l'Ecuyer, J. (Univ. of California, Berkeley). Astrophys. J., 156: 549-58(May 1969).**

Subject to certain approximations and simplifications, the order of magnitude of the time scale for the diffusion of energy in nonconvective regions is studied. Under a considerable variety of circumstances, it is shown that a reasonably dependable estimate for the time needed to carry energy, initially deposited at a radius r_0, to a radius r is $\tau = 3/64\sigma\, [\int_{r_0}^{r} (\kappa C_p/T^3)^{1/4}\, \rho dr]^2$. When certain large variations in the several parameters are present, a more accurate value is about half of this. The behavior of the quantity, $\omega = r\, (16\sigma T^3 C_p/3\kappa)^{1/4}$, is particularly critical in this regard. Nearly zero values of r and r_0 also tend to reduce the time scale. (auth)

27230 PULSAR SCINTILLATIONS DUE TO DISTANT STREAMING COSMIC RAYS. **Wentzel, Donat G. (Univ. of Maryland, College Park). Astrophys. J., 156: L91-5(May 1969).**

Scintillation of pulsar radio emission indicates the existence of interstellar hydromagnetic waves that interact with and probably are caused by cosmic rays. Measurable characteristics of the scintillation can determine the spectrum of the hydromagnetic waves. Observation that most waves are shorter than roughly 10^{12} cm could inform about the mean streaming velocity of distant cosmic rays, the cause of their streaming, and the degree of interstellar ionization in that region of space. An observation of wavelengths of 10^{11} cm would demonstrate the existence of interstellar protons below 1 MeV or of electrons near 25 MeV. (auth)

27231 ACTIVITY IN THE CRAB NEBULA. **Scargle, Jeffrey D. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astrophys. J., 156: 401-26(May 1969).**

A series of 200-inch continuum and polarization plates of the Crab Nebula was studied in connection with the activity discovered by Lampland and Baade. A number of sharply defined features near the center show changes which correspond to relativistic velocities, but there is also evidently subtler activity throughout the Nebula. This activity is concentrated toward the northwest quadrant of the Nebula, and is slower and less conspicuous with increasing distance from the center. The bright main wisp seems to be a permanent compressed region which moves as a whole in a reciprocating manner, but the other apparent motions may be regarded as propagating hydromagnetic disturbances. The continuous spectrum seems to be correlated with the activity in the sense that it is flatter (i.e., α is smaller) close to the center where the activity is most violent, and steeper toward the edges of the Nebula. (auth)

27232 THE PLANETARY NEBULAE. I. Aller, Lawrence H. (Univ. of California, Los Angeles). Sky Telesc., 37: 282-6(May 1969).

A brief description of planetaries is given along with an account of their discovery. Properties of the planetaries in the Milky Way is discussed and the problems inherent in observing them in nearby galaxies are mentioned. The various methods and approaches for determining the distances of planetaries are covered. (W.D.M.)

27233 PHOTOELECTRIC OBSERVATIONS OF ET PEGASI. Basu, B. (Univ. of California, Berkeley). Astrophys. J., 156: 785-6(May 1969).

ET Pegasi was observed in UBV colors. A period entirely different from that given by Kaho and a new time of maximum light were obtained. The variable has an extremely sharp rise to maximum and also a sharp minimum. The large scatter in the light curve at the pre-minimum and post-maximum phases suggests poor repetition from cycle to cycle. (auth)

27234 ON THE THEORETICAL (U - B)- AND (B - V)-COLORS. Matsushima, Satoshi; Hall, David L. (Pennsylvania State Univ., University Park). Astrophys. J., 156: 779-83(May 1969).

Recent recalibration of the absolute energy spectrum of Vega by Hayes (1967) has shown a large discrepancy from the photometric standard previously used for calibration. The magnitude of the correction required by the new calibration for the transformation formulae was investigated. (W.D.M.)

27235 OBSERVATION OF THE LYMAN ALPHA INTERSTELLAR ABSORPTION LINE IN THETA ORIONIS. Carruthers, George R. (Naval Research Lab., Washington, D. C.). Astrophys. J., 156: L97-100(May 1969).

A rocket observation of the Lyman-α interstellar absorption line of atomic hydrogen in the far-ultraviolet spectrum of θ Orionis indicates an equivalent width of 16 ± 4 Å, corresponding to a column density of about 5×10^{20} hydrogen atoms cm^{-2} or about one-fifth of that indicated by the 21-cm absorption measurements if a spin temperature of 100°K is assumed. In contrast to the 21-cm emission measurements, the 21-cm absorption measurement is, like the Lyman-α measurement, over a well-defined line of sight, and, if the same H(I) clouds are assumed to be responsible for the radio and the ultraviolet absorptions, a spin temperature of about 20°K is indicated for these clouds. It appears unlikely that the Lyman-α profile is determined primarily by the less reddened θ^2 component, which might not lie behind as much of the 21-cm observed hydrogen as the hotter but more reddened θ^1 component. (auth)

27236 IDENTIFICATION OF Pt II IN THE SPECTRA OF SOME PECULIAR A STARS. Dworetsky, Michael M. (Univ. of California, Los Angeles). Astrophys. J., 156: L101-2(May 1969).

Evidence is presented for the identification of several lines in the spectrum of HR 4072 as Pt(II). The same lines appear in the spectra of several other peculiar stars. (auth)

27237 CHANGES IN POLARIZATION OF T TAURI STARS. Serkowski, K. (Australian National Univ., Canberra). Astrophys. J., 156: L55-7(May 1969).

The percentage polarization of the T Tauri star AK Scorpii is changing from 0.3 to 0.8% and its position angle from about 60 to 145°. The changes in percentage polarization are observed also for T Tauri itself. (auth)

27238 ON THE SCHEME OF INVESTIGATION OF THE RECOMBINATION SPECTRA OF COMPLEX ATOMS. II. Nikitin, A. A. Uch. Zap. Leningrad. Gos. Univ., No. 337, Ser. Mat. Nauk, No. 42, 17-27(1968). (In Russian).

Peculiar atomic recombination spectra of stars and nebulae of the complex are considered. Some properties of the complex atoms and their recombination spectra are investigated from the astrophysical point of view. (auth)

27239 ON THE CHANGES OF IONIZATION IN THE ATMOSPHERE OF THE CEPHEID RU CAM. Korovyakovskii, Yu. P. Uch. Zap. Leningrad. Gos. Univ., No. 337, Ser. Mat. Nauk, No. 42, 27-31(1968). (In Russian).

It was found from the molecular band variations that the amplitude of temperature variation in the atmosphere of RU Cam is very small. It is shown that this fact can be explained by the minor role of radiative processes of ionization in the upper layers of the atmosphere as compared with the role of the collisional processes. (auth)

27240 TIME CHANGES OF THE POLARIZATION OF RADIATION OF SOME VARIABLE STARS. Dombrovskii, V. A.; Polyakova, T. A.; Yakovleva, V. A. Uch. Zap. Leningrad. Gos. Univ., No. 337, Ser. Mat. Nauk, No. 42, 32-45(1968). (In Russian).

The results of the polarimetric observations of the variable stars μ Cep, V CVn, R Sct, Z Lac, and SS Cyg made at Byurakan station of the Leningrad University Astronomical Observatory are given. The time variations of the polarization for μ Cep, V CVn, and R Sct were found. (auth)

27241 POSSIBILITY OF DETECTING OF THE THERMAL RADIOEMISSION OF STARS. Gelfreikh, G. B.; Kuznetsov, B. G. Uch. Zap. Leningrad. Gos. Univ., No. 337, Ser. Mat. Nauk, No. 42, 54-7(1968). (In Russian).

The expected flux densities of the thermal radio emission from stars of different spectral classes are estimated. The flux densities of photospheres and chromospheres are below the limit of fluctuation sensitivity and resolving power of modern radiotelescopes, with the one possible exception of red supergiants. The presence of opaque corona, however, may allow to detect the radio emission of some of the nearest stars. The large optical thickness of the corona may be due to the large emission measure as well as due to the strong magnetic field. (auth)

27242 THEORETICAL AND OBSERVED DISTRIBUTIONS OF TRIPLE-STAR CONFIGURATIONS. Anosova, Zh. P. Uch. Zap. Leningrad. Gos. Univ., No. 337, Ser. Mat. Nauk, No. 42, 100-12(1968). (In Russian).

The theoretical and observed distributions of the configurations of triple stars having different mass ratios of the components were obtained. It was found that the theoretical distribution is similar to the observed one. It may be considered an indication of the instability of all triple systems, in the sense that there are no nearly elliptical motions. (auth)

27243 B-EMISSION STARS AND GALACTIC ROTATION. Crampton, David. Toronto, Univ. of Toronto, 1967.
Thesis.

The emission-line stars in the spectral region B0–B2 are very young, bright objects which apparently lie slightly above the main sequence in the Hertzsprung–Russell Diagram. Since the Be stars are easily identified from H α objective prism surveys, nearly all the B0–B2e stars within a few kiloparsecs of the Sun are known. Schmidt-Kaler has published a catalogue of spectral types, colors, and distances of B0–B3 (III–V)e stars which is statistically complete to about two kiloparsecs for the B0–B2 (III–V)e stars. The distances were derived from Schmidt–Kaler's absolute magnitude calibration which is based on Be stars which are members of galactic clusters, of 0B associations or of binary systems. Be stars have been observed at the David Dunlap Observatory since 1937, so that a large collection of spectrograms exists in the files. Radial-velocity measures were made of these plates and of newly-acquired spectrograms of 60 additional Be stars. These measures and a tabulation of published velocities for 225 Be stars are listed in an appendix. The new data nearly complete the determination of the radial velocities of the B0–B2e stars within 1.5 kpc of the Sun. Hence these stars form an essentially statistically complete sample of young bright stars upon which a kinematic study of the local region of the Galaxy may be based. (Disser. Abstr.)

27244 THE INTERSTELLAR EXTINCTION OF STARS IN H II REGIONS. Anderson, Christopher Marlowe. Pasadena, Calif., California Inst. of Tech., 1968. 139p.
Thesis.

Spectrophotometric observations of several stars which appear to be associated with HII regions have been obtained in an attempt to locate other occurrences of the reddening anomaly which is seen in the Trapezium stars (θ^1 Orionis) in the Orion Nebula. Several cases of the Orion-like anomaly have been found. The radiation pressure mechanism for the removal of the smallest grains from the nebula has been discussed and has been found to be inoperative because of the drag forces acting upon the grains. It has been shown that the temperature of the grains depends upon the grain size such that the smaller grains might experience more rapid evaporation. The processes of grain–grain fusion and condensation nucleus exhaustion have been investigated as possible causes of the anomalous grain size distribution. Finally, the anomaly has been discussed as if it were a peculiarity in the intrinsic colors of the stars. The large infrared excess observed in these stars could be due to the presence of late-type stellar companions or circumstellar shells. (Disser. Abstr.)

27245 EVOLUTION OF A 30-SOLAR-MASS POPULATION I STAR. Schindler, Alan Michael. Waltham, Mass., Brandeis Univ., 1968. 174p.
Thesis.

The evolution of a Population I star of 30 $M_\odot$ is followed from the wholly convective gravitationally contracting stage. The initial chemical composition is taken to be $X_1 = 0.74$, $X_4 = 0.24$, $X_{12} = 0.00352$, $X_{14} = 0.000749$, and $X_{16} = 0.00815$. In the H−R diagram the star at first decreases in luminosity at almost constant log $T_e = 3.55$. As a radiative core grows the effective temperature increases and at log $T_e = 3.61$, log $(L/L_\odot) = 4.45$ the curve passes through a minimum. In this region the opacity depends on temperature and density and so the luminosity increases as the temperature rises. With further increase in temperature the opacity is determined by electron scattering and the luminosity becomes nearly constant. Near log $T_e = 4.45$, log $(L/L_\odot) = 5.146$, nuclear reactions begin to play a significant role with the depletion of ^{12}C and the growth of a convective core. There is a dip in the luminosity. About the time when the original ^{12}C has been almost exhausted, ^3He begins to be depleted. After the onset of ^3He depletion there is a rapid increase in the size of the convective core. This leads to an expansion of the stellar radius and a sharp drop in luminosity. After the new ^{12}C mixed into the core is exhausted the radius decreases, luminosity increases, and the depletion of ^3He continues. The position in the H−R diagram of the main sequence star is different from that found by other investigators of the 30$M_\odot$ case. These differences are accounted for by differences in initial chemical composition, opacity tables, and surface boundary conditions. (Disser. Abstr.)

27246 THIRD FAMILY OF STABLE EQUILIBRIA? Gerlach, Ulrich Horst. Princeton, N. J., Princeton Univ., 1968. 106p.
Thesis.

This thesis deals with some basic aspects of degenerate superdense stars within the framework of general relativity. It incorporates a review of some of the current evidence pointing towards the existence of these stars. The stability of sequences of stars made of matter obeying arbitrary equations of state is analyzed with the help of a new, practical variational principle. The remainder of this work is devoted to obtaining a relationship between externally observable data of a sequence of superdense stars, such as, the total mass and the total radius, and conditions at the center, such as the central density and the compressibility of the matter. This relationship is used to deduce an equation of state that would allow superdense tertiary stars (a third family of stable equilibrium configurations). (Disser. Abstr.)

27247 EMPIRICAL DETERMINATION OF THE INTERSTELLAR RADIATION FIELD. Lillie, Charles Frederick. Madison, Wis., Univ. of Wisconsin, 1968. 110p.
Thesis.

The interstellar radiation field in the 2000 to 5560-Å region was determined from photoelectric observations of the night-sky brightness obtained with an Aerobee rocket in the ultraviolet and with a ground-based telescope in the visual region. The sky was scanned from horizon to horizon along twenty separate paths at 2100, 2500, 2800, 3250, 3580, 4100, 4300, 4900, 5400, and 5577 Å. The observed sky brightness was separated into three components by fitting the intensity distributions for airglow, zodical light, and interstellar light to the data with a least squares technique. (Diss. Abstr.)

27248 SEVEN-COLOR INTERMEDIATE-BAND PHOTOMETRY. McClure, Robert Douglas. Toronto, Univ. of Toronto, 1968.
Thesis.

Results of a program of photoelectric seven-color intermediate-band photometry undertaken with the 188-cm reflector of the David Dunlap Observatory are reported. The adopted seven color system was used to measure the six color indices. A total of 210 stars, 55 galaxies, and 12 globular clusters was measured. It is shown that the adopted seven-color system can be used to determine both the spectral types and the luminosity classes of reddened stars. (Disser. Abstr.)

27249 AN INVESTIGATION OF SHORT-PERIOD VARIABLE STARS. I. THE DELTA SCUTI STARS. Bessell, M. S. (Australian National Univ., Canberra). Astrophys. J., 18: Suppl. Ser. No. 160, 167-94(Apr. 1969).

Photoelectric continuum observations between 3390 and 10400 Å were obtained for the MKK standard stars η Lep F0 V and α CMi F5 IV (Procyon) and for the Delta Scuti stars ρ Pup, δ Sct, and δ Del over complete cycles. Coudé spectra covering from 3390 to 6700 Å were obtained to measure the Hγ profile and to correct the observed fluxes for line blanketing. The resultant energy distributions and profiles were compared with the model-atmosphere computations of Mihalas and of Searle and Oke to derive the effective temperatures and gravities. For each star the same value of the effective temperature was derived from both the Hγ profile and the energy distribution. From a fitting of the continuum of Procyon to the Mihalas computations it was found that the true gravity of Procyon could only be derived by adopting the solar value of He/H = 0.11 for the model composition, instead of the value of 0.15 used by Mihalas. Large anomalous line blanketing in the blue-violet region was found for ρ Pup and δ Sct, and curve-of-growth analyses relative to η Lep showed that the line strengthening in these stars was due to high microturbulence and an apparent overabundance of the iron-group elements. These peculiarities and the low Ca/Fe and Sc/Fe-ratios also found for δ Sct, δ Del, and ρ Pup are similar to the properties of metallic-line stars. The masses of the Delta Scuti stars determined from the observed temperatures and gravities are consistent with normal left-to-right evolution in the HR diagram for stars of about 1.9 $M_\odot$. The space motions of all the known Delta Scuti stars support the temperature of their being old A stars. (auth)

27250 AN INVESTIGATION OF SHORT-PERIOD VARIABLE STARS. II. THE AI VELORUM STARS. Bessell, M. S. (Australian National Univ., Canberra). Astrophys. J., 18: Suppl. Ser. No. 160, 195-220(Apr. 1969).

The AI Velorum stars, often called dwarf Cepheids, are those stars with periods shorter than 0.25d classed as RR Lyrae stars in the General Catalogue of Variable Stars. The colors, space motions, and statistical parallaxes of all these AI Velorum stars are investigated, and the results of a spectrophotometric and spectroscopic analysis of the variations of AI Vel, SX Phe, and HD 199757 are given, together with infrared colors of VZ Cnc. The effective temperatures and gravities of the former stars were determined by comparing the blanketing-corrected continua and the Hγ profiles (except for HD 199757) with the model-atmosphere computations of Mihalas, and the effective temperature of VZ Cnc was derived from a calibrated $(V - R, \theta_e)$-relation. It was found that the temperatures and gravities of these AI Velorum stars were much higher than the values obtained for any of the longer-period RR Lyrae stars; however, the luminosities were much lower, trigonometric parallaxes giving $M_b = 3.0 \pm 1.0$ and 3.5 ± 0.5, respectively, for AI Vel and SX Phe. Masses of about 0.5 $M_\odot$ were determined for the AI Velorum stars, and the values of the pulsation constant Q_0 range from 0.030 to 0.034. AI Vel, SX Phe, and VZ Cnc are pulsating in the fundamental mode, while HD 199757 may be a first-overtone pulsator. The space motions of the AI Velorum stars are higher than the Hyades group but lower than the metal-rich RR Lyrae stars, and from a curve-of-growth analysis of AI Vel and SX Phe the metal abundances were found to be equal to the solar values and one-quarter of the solar values, respectively. The AI Velorum stars are probably post-helium-flash stars; however, because of their low luminosities they do not correspond to any of the helium-core-burning horizontal-branch models considered by Faulkner and Iben. (auth)

Quasi-Stellar, Radio, and X-Ray Sources

Refer also to abstract 26539.

27251 (AD-674265) PLASMA MODEL OF QUASARS AND RADIO GALAXIES. Sturrock, P. A. (Stanford Univ., Calif. Inst. for Plasma Research). May 8, 1968. Contracts AF-49(638)-1321; N00014-67-A-0112. 30p. (SU-IPR-99; AFOSR-68-1809). CFSTI.

The phenomena associated with quasi-stellar objects (quasars) as plasma phenomena are discussed. Admittedly, this is at best a partial treatment of the problem, since it omits atomic and nuclear processes; but it does seem to offer the best hope of understanding the observations of high-energy radiation, and it does lead to a model of what these objects are and how they form, which can then be studied from other points of view. (auth) (USGRDR)

27252 (AD-677560) THE OCCULTATION OF THE CRAB NEBULA BY THE SOLAR CORONA IN JUNE 1960. Research Note. Erickson, W. C.; Brissenden, P. (Convair Scientific Research Lab., San Diego, Calif.). July 1961. Contract AF-49(638)-561. 8p. (RN-50). CFSTI.

Observations of the occultation of the Crab Nebula by the solar corona were made in June 1960. These observations were made at the Clark Lake radio astronomy station at a wavelength of 11.4 meters. They are very similar to those made in 1959 and reported previously. Most of these observations were again obtained with a fan beam antenna whose response pattern measures 1.5° E−W and 30° N−S. The radio noise output of this antenna was determined with a comparison radiometer which measured the difference between the antenna noise and the output of a regulated noise source. (auth) (USGRDR)

27253 (AD-678601) HIGH-RESOLUTION STUDIES OF DISCRETE RADIO SOURCES. Final Report, February 1, 1967-August 31, 1968. Cohen, M. H. (California Univ., La Jolla, San Diego). Sept. 1968. 11p. (AFOSR-68-1925). CFSTI.

The main objective was to make diameter and structure measurements on compact radio sources. Two techniques, both in the process of development, were employed: interplanetary scintillations, and very-long-baseline interferometry using independent local oscillators. (USGRDR)

27254 (N-69-17962) AN X-RAY SURVEY OF THE SKY FROM BALLOON ALTITUDES, DECEMBER 1965-JULY 1967. Riegler, Guenter Rudolf (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Jan. 1969. 193p. (NASA-TM-X-63422; X-611-69-1). CFSTI.
Thesis. Submitted to Univ. of Maryland, College Park.

A series of balloon-borne x-ray experiments was carried out between December 1965 and July 1967. The x radiation in the energy band from 12 to 60 keV was detected with a combination of proportional and scintillation counters. A clear relation between the background counting rate at a residual atmospheric depth of 3 g/cm^2 and the geomagnetic latitude was found. The secondary atmospheric x-ray background is assumed to be a component of atmospheric electromagnetic cascades that originate in the collisions of high-energy cosmic-ray particles with atmospheric nuclei; other x-ray production processes near the top of the atmosphere are shown to be insufficient to explain the observed secondary background. The correct prediction of the geomagnetic latitude effect is shown to constitute a stringent test for models of atmospheric x-ray production. Two observations of the Crab Nebula (Tau XR-1) resulted in net source spectra which can be described by a power law photon spectrum with a spectral index of $-0.09 < n = 1.93 \leq +0.13$. A comparison with the results of measurements by other experimenters at lower and higher energies indicates that the x-ray spectrum of Tau XR-1 is a power law of index $n = 2.0$ at energies between 2 and 400 keV. (auth) (STAR)

27255 (N-69-18108) PULSAR EMISSION MECHANISM. Michel, F. C.; Tucker, W. H. (Rice Univ., Houston, Tex. Dept. of Space Science). Feb. 1969. 16p. (NASA-CR-99490). CFSTI.

It is pointed out that the interaction between two basic types of plasma discontinuities in relative motion, namely the tangential and shock discontinuties, should result in pulsed emission of electromagnetic radiation. These discontinuities are both observed in the interplanetary plasma flow. Currents must flow on these discontinuities, and the radiation is generated by the acceleration of these currents at the intersection points of the shock and tangential discontinuities. Under conditions thought applicable to pulsars, NP 0532 would radiate about 4×10^{30} erg/sec of radio energy below about 10^3 MHz. The efficiency of this mechanism is quite low ($\approx 10^{-6}$ for NP 0532) for the assumed conditions, and direct extension to the much slower pulsars would require that they have moments of inertia much larger than attributable to neutron stars. (auth) (STAR)

27256 (N-69-18175) DISCRETE SOURCE INTERPRETATION OF RECENT HIGH-ENERGY COSMIC GAMMA-RAY MEASUREMENTS. Oegelman, Hakki (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Dec. 1968. 11p. (NASA-TM-X-63420; X-611-68-487). CFSTI.

Gamma-ray detector data, obtained during OSO-3 flight, show an angular distribution of events. The theory that most of this flux is due to unresolved discrete sources is evaluated by predicting the spectral index from total measured fluxes in the x-ray and gamma-ray region and by comparing it to measurements of the power law index in the soft and hard x-ray region; the extrapolated x-ray power law differential exponent evolved as -2.1. This predicted -2.1 spectra fits well with experimental measurements up to 0.5 MeV. The fact that one single spectral index may account for the fluxes from x-ray to high-energy gamma ray region implies that the mechanism responsible for this emission could not be synchrotron radiation because of the short lifetimes of electrons radiating the gamma rays. (STAR)

27257 SEARCH FOR X-RAY POLARIZATION IN Sco X-1. Angel, J. R. P.; Novick, R.; Vanden, Bout, P. Wolff, R. (Columbia Univ., New York). Phys. Rev. Lett., 22: 861-5(Apr. 21, 1969).

An x-ray polarimeter sensitive to x rays in the energy range from 6 to 18 keV, flown above the atmosphere on July 27, 1968, was used both to set an upper limit on the polarization of Sco X-1 and to check for spurious indications of polarization which might result from the anisotropy of the cosmic rays. Within the statistical limitations of the data, no evidence was found for spurious background polarization. (auth)

27258 AUSTRALIAN RADIOHELIOGRAPH PROJECT. Higgs, A. J. (CSIRO, Sydney). Telecommun. J., 35: 521-4(Oct. 15, 1968).

A new radiotelescope designed to produce second-by-second pictures of the Sun by its emission at 80 MHz has recently been completed by the Radiophysics Division of CSIRO. This radioheliograph, located at Culgoora, New South Wales, will study the intense short-lived disturbances in the solar atmosphere which are responsible for "bursts" of radio emission. It is the first circular array to be used in radio-astronomy, and the first radiotelescope to provide a virtually instantaneous two-dimensional picture over a substantial field of view (2°). An important objective is the ability to locate even small sources of bursts, some of which may occupy 1% of the Sun's visible disk. A diameter of 3 km was used to achieve this resolution at 80 MHz. The solution adopted was 96 separate parabolic aerials, each 13 m in dia, equally spaced around the perimeter. A basic picture rate of 1/sec is adequate to allow the development of all but the finest structure to be followed. Arrangements are provided for each picture to be duplicated in both senses of circular polarization; the time taken for each picture is thus 0.5 sec. The effective picture field is a rectangle of 2880 picture points and the integration time per point 1/120 sec. The first bursts to be recorded occurred between 0222 and 0228 UT on September 2, 1967. The pictures showed that distinct and well-separated storm regions co-exist even during periods of minor activity; and that individual bursts of a group may originate from different centers, but sometimes in a manner that suggest physical connection between them, even though the separation may be more than a solar radius. The link is presumably by electron streams already thought to be the sources of many solar bursts. (BBB)

27259 X-RAY PULSAR IN THE CRAB NEBULA. Fritz, G.; Henry, R. C.; Meekins, J. F.; Chubb, T. A.; Friedman, H. (Naval Research Lab., Washington, D. C.). Science, 164: 709-12 (May 9, 1969).

X-ray pulsations have been observed in the Crab Nebula at a frequency closely matching the radio and optical pulsations. About 5% of the total x-ray power of the nebula appears in the pulsed component. The x-ray pulsations have the form of a main pulse and an interpulse separated by about 12 milliseconds. (auth)

27260 PULSARS. Hewish, Antony (Churchill Coll., Cambridge, Eng.). Endeavour, 28: 55-9(May 1969).

The consensus of opinion is that pulsars are in fact neutron stars whose existence had hitherto been only a hypothetical possibility. An authoritative survey of the present knowledge of pulsars and of the various models that have been proposed to account for their physical properties is presented. (auth) (UK)

27261 OPTICAL CANDIDATE FOR PULSAR PSR 0833-45. Cocke, W. J.; Disney, M. J.; Westerlund, B. E. (Univ. of Arizona, Tucson). Nature (London), 222: 359(Apr. 26, 1969).

A promising pulsar candidate for detection of optical radiation is PSR 0833-45, which is associated with the Vela supernova remnant and which has a period of 89ms. It was thought that direct plates taken with U and B filters might be sufficient to identify optical candidates, and such plates were taken with the Curtis-Michigan 24/36 inch f/3.8 Schmidt telescope at the Cerro Tololo Inter-American Observatory in Chile. A stellar candidate was observed and its position determined. There was a suggestion of faint nebular wisps emanating from this star. (UK)

27262 PULSARS AND NEUTRON STAR FORMATION. Arnett, W. D. (California Inst. of Tech., Pasadena). Nature (London), 222: 359-61(Apr. 26, 1969).

Reference is made to the hypothesis of rotating neutron stars as an explanation of pulsars. This suggests re-examination of the problem of the formation of neutron stars, and in particular examination of the predictions of the theory of stellar evolution concerning the formation of neutron stars and the type of object from which they are formed. It is suggested that pulsars are formed from massive O stars; observational tests of this hypothesis are possible and are discussed. The arguments of Hoyle, Chiu, Fowler, Colgate, and White in this field are briefly summarized, and it is stated that none of their analyses allows estimation of which main sequence stars will form neutron stars at the end of their lives. The present author considers the evolution of a He-burning shell which surrounds a degenerate core of the C and O which are formed in He burning. Arguments are presented which imply that nonviolent ignition of both C and O is a prerequisite for neutron star formation, and mass effects are discussed. Direct electron-neutrino coupling in the weak interaction is assumed. If pulsars are produced from O stars correlation between the distribution of pulsars and O stars is to be expected; some pulsars would be expected to form near OB associations, and high-velocity "runaway" O stars could also be a source of pulsars. Such a correlation should be subject to observational test, and present pulsar data seem to be consistent with this correlation. The predictions do not hold if a direct neutrino-electron coupling does not exist in the weak interaction. Spherical symmetry is assumed throughout the discussion, and although this is correct for H and He burning stages, there is no evidence regarding its validity for later stages of stellar evolution; it is not clear, however, that a consideration of nonspherical effects, such as rotation, would affect the arguments presented. (UK)

27263 SPECTRUM AND POLARIZATION OF A SOURCE OF SYNCHROTRON EMISSION WITH COMPONENTS FLYING APART AT RELATIVISTIC VELOCITIES. **Ozernoi, L. M.; Sazonov, V. N. (Lebedev Inst. of Physics, Moscow). Astrophys. Space Sci., 3: 395-423(Mar. 1969).**

The frequency spectrum, time variations, and polarization of the flux of synchrotron radio emission from a source which consists of two components flying apart in opposite directions with relativistic velocities at the same time expanding were considered. A comparison of the calculations with unusual "double-humped" spectra of some radio sources suggests the existence in their nuclei of such double components which are at an early stage of relativistic ejection. In particular the double-humped spectra of 3C 84 and 4C 50.11/NRAO-150 can be interpreted in the proposed model. In this model the ratio of maximum frequencies ν_{1m}/ν_{2m} should be larger than that of the maximum fluxes $F_{\nu 1 m}{}^{(1)}/F_{\nu 2 m}{}^{(2)}$. The linear polarization of the double-humped spectrum is analyzed. It is found under rather specific conditions that at the low-frequency maximum of the spectrum, a lower degree of linear polarization is expected than at the high-frequency maximum. In addition, it is natural to expect the appearance of circular polarization in sources with internal large-scale relativistic motions. The time variations of the radio flux of some QSS, N galaxies, and nuclei of Seyfert galaxies can also be interpreted in the suggested model of two clouds of relativistic electrons flying apart in different directions with relativistic velocities while simultaneously expanding. For example, the flux variations at 3 frequencies whose ratio is 16 : 4 : 1 are shown. This picture is similar to the observations of 3C 279 at 3.4 mm, 2 cm, and 6 cm, and several other sources (Keller-Mann and Pauliny-Toth, 1968). There have been a number of attempts to explain the flux variations of radio sources in the model of successive, but unrelated outbursts of clouds of relativistic electrons caused by supernova explosions. This model meets many difficulties and seems improbable. Experimental tests are suggested to make a final choice between the model of double components flying apart relativistically and the model of two successive, but unrelated, outbursts from supernovae. If the suggested model of explosions in radio sources is correct, then the processes of variable energy output in such different populations as QSS, N galaxies, radio galaxies, and the nuclei of normal galaxies have a similar nature, differing only in quantity. (auth)

27264 CONSISTENT ANALYSIS OF GAMMA-RAY ASTRONOMY EXPERIMENTS. **Hearn, D. (Smithsonian Institution, Cambridge, Mass.). Nucl. Instrum. Methods, 70: 200-4(Apr. 15, 1969).**

A general procedure is proposed for analyzing and reporting results of gamma-ray astronomy experiments. A single set of variables is to be used for all types of experiments, to allow unambiguous comparison of instruments and results. Upper (or lower) limits to the number of counts from a source are obtained from a likelihood function. The upper limits from this method are often larger than those obtained by approximate methods previously used. An effective efficiency of detection, compensating the flux value or limit for the steep slope of the background spectrum, decouples the significance of the result from the energy threshold quoted. The observed intensity of background gamma radiation should also be reported, and source fluxes expressed as ratios to the background at the given atmospheric depth, as well as in photons $(cm^2 \cdot sec)^{-1}$. (auth)

27265 INFRARED PUMPING OF INTERSTELLAR OH. **Litvak, M. M. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J., 156: 471-92(May 1969).**

Infrared pumping is shown to produce maser emission in the OH ground state at 1612 or 1720 MHz in close-by, cool OH clouds, and at 1665 or 1667 MHz in sufficiently hot or turbulent ones. The population inversion is caused by a nonthermal transfer of population between the hyperfine-split states that is due to far-IR resonance-radiation trapping and fluorescence. This radiation is generated either by an external far-IR flux (from an extended source like the Orion far-IR nebula), which is absorbed by the OH rotational states, or by the fluorescence from these states following cascading from higher states, such as the vibrational states that are excited by external near-IR radiation (from a near-IR point source or a protostar containing optically thick OH that radiates resonance lines). Unsaturated population inversion and saturated maser output are obtained using calculated intensities of resonance radiation within clouds having projected OH densities of 10^{15} to 10^{17} cm^{-2}. A comparison of the calculations with the anomalous absorption data suggests that the densities are ~10^5 to 10^6 H cm^{-3} and $\gtrsim 10^{-1}$ OH cm^{-3}, that the 1720-MHz emitters may be pumped by far-IR extended sources and the 1612-MHz emitters by very close near-IR sources. (auth)

27266 NEUTRAL HYDROGEN IN DARK DUST CLOUDS. **Heiles, Carl (Univ. of California, Berkeley). Astrophys. J., 156: 493-9(May 1969).**

Forty-eight dark dust clouds were surveyed in the 21-cm line. One shows the expected excess of H(I), and its 35°K emission line is probably saturated, but two show deficiencies; the H(I) structure around another is interestingly complex. All the rest do not obviously display their presence of H(I). It is shown that this cannot result from saturation effects of low-temperature H(I); it is tentatively attributed to the hydrogen being molecular; but other causes—in particular, frozen hydrogen mantles on dust grains—could also be responsible. (auth)

27267 DISSOCIATION OF MOLECULES BY THE ABSORPTION OF LINE RADIATION. **Werner, Michael W. (Cornell Univ., Ithaca, N. Y.). Astrophys. J., 156: 753-60(May 1969).**

A theory is developed describing the dissociation of a cloud of molecules through processes initiated by the absorption of line radiation. The theoretical results are applied to the problem of the dissociation of H_2 molecules in H(I) regions by photons of the mean interstellar ultraviolet-radiation field. It is shown that the mean interstellar H_2 density will be very low, and that the lifetime of a small group of H_2 molecules in the interstellar medium will be very short. However, it is also found that large groups of molecules (column densities greater than ~10^{18} [cm^2 column]$^{-1}$) will survive for more than 10^7 yr under interstellar conditions. The significance of these results for other problems related to interstellar H_2 is briefly discussed. (auth)

27268 THE RADIO-FREQUENCY SPECTRUM OF H_2^+. **Luke, S. K. (National Research Council of Canada, Ottawa). Astrophys. J., 156: 761-9(May 1969).**

For the $^2\Sigma$ ground electronic state of H_2^+ the first-order rho-type doubling constant d′ is calculated for the first nine vibrational energy levels. The values of d′ for the vibrational levels with v = 6 and v = 7 agree to better than 0.4 MHz with the experimental measurements of Jefferts. This result and some rough theoretical estimates indicate that the second-order contribution d″ is very small. With a value of d that takes into account the vibrational effects, a recalculation of the hyperfine structure of ortho-H_2^+ (N = 1) has yielded radio frequencies which are probably reliable to better than 1 MHz. (auth)

27269 2 TO 20-keV SPECTRUM OF X RAYS FROM THE CRAB NEBULA AND THE DIFFUSE BACKGROUND NEAR GALACTIC ANTICENTER. **Boldt, Elihu A.; Desai, Upendra D.; Holt, Stephen S. (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J., 156: 427-36(May 1969).**

Data are presented from a rocket-borne exposure to x rays from the Crab Nebula and its apparently source-free neighborhood on the celestial sphere near galactic anticenter. With ~2 keV resolution, the Crab Nebula is found to have a structureless spectrum which is consistent with a power law of index −1.93 ± 0.05 in the differential photon flux between 2 and 20 keV, in substantial agreement with results of investigators using balloon-borne detectors at higher energies. The diffuse x-ray background is found to exhibit a harder spectrum than the Crab Nebula in the same energy range. The 2 to 20 keV background spectrum, with index −1.3 ± 0.1 is significantly flatter than that reported at higher energies. (auth)

27270 ABSORPTION LINES PRODUCED BY GALACTIC HALOS. **Bahcall, John N. (Inst. for Advanced Study, Princeton, N. J.); Spitzer, Lyman Jr. Astrophys. J., 156: L63-5(May 1969).**

It is proposed that most of the absorption lines observed in quasi-stellar sources with multiple absorption redshifts are caused by gas in extended halos of normal galaxies. (auth)

27271 QUASARS SIX YEARS LATER. **Green, Louis C. (Haverford Coll., Pa.). Sky Telesc., 37: 290-4(May 1969).**

The present state of knowledge on quasars is reviewed in terms of numbers and properties, redshifts, and models. (W.D.M.) .

27272 FURTHER SIMULTANEOUS OBSERVATIONS OF THE OPTICAL AND X-RAY SPECTRA OF SCO X-1. **Mark, Hans (Univ. of California, Livermore); Price, R. E.; Rodrigues, R.; Seward, F. D.; Swift, C. D.; Hiltner, W. A. Astrophys. J., 156: L67-72(May 1969).**

Simultaneous observations have again been made of the fluctuating optical and x-ray emission from Sco X-1. Previous measurements and a discussion of possible correlation have been published. Two new measurements are reported here in which the optical intensity was relatively faint (B = 13.14 and 13.22 mag). The x-ray intensity was 2.5×10^{-7} and 2.2×10^{-7} erg cm^{-2} sec^{-1} between 2 and 20 keV, and the apparent plasma temperatures (KT) were 7 and 5.5 keV. An extrapolation of the x-ray spectrum was compared with the observed optical spectrum, yielding agreement. Parameters, viz., plasma radius and density and total energy flux, of a model previously proposed are inferred from the present data. It is noted that the total energy flux is greatest when the object is brightest. (auth)

27273 SEARCH FOR OPTICAL PULSATIONS FROM THE VELA PULSAR. Warner, B.; Nather, R. E. (McDonald Observatory, Austin, Tex.). Nature (London), 222: 254-5(Apr. 19, 1969).

The detection of optical pulsations from the pulsar NP 0532 in the Crab Nebula has stimulated a search for optical radiation from other radio pulsars. Of known pulsars PSR 0833-45 has properties most similar to those of the Crab pulsar, and also appears to be associated with a supernova remnant (Vela X). A search for optical pulsations from the Vela pulsar was conducted using the 82-inch Struve reflector at McDonald Observatory, and the field of this pulsar is shown. No optical pulsations were detected; this failure to find the Vela pulsar implies an upper limit on its optical brightness which is a factor of 50 lower than that of the Crab pulsar. Inspection of Palomar sky survey plates indicated the presence of an interstellar absorbing cloud close to and possibly covering the radio position of the pulsar, and if this cloud is between the Vela pulsar and the Earth pulsations will be extremely difficult to detect optically. A search at ir wavelengths might be more successful. (UK)

27274 A SEARCH FOR ENERGETIC GAMMA-RAY EMISSION FROM THE SUPERNOVA REMNANT CASSIOPEIA A. May, T. C.; Waddington, C. J. (Univ. of Minnesota, Minneapolis). Astrophys. J., 156: 437-44(May 1969).

The radio source Cassiopeia A was examined for evidence of emission of energetic, E ≥ 200 MeV, gamma rays. This observation was made from a high-altitude balloon using a high-resolution gamma-ray telescope composed of various electronic detectors, spark chambers, and nuclear emulsions. In spite of an order-of-magnitude reduction in sensitivity consequent upon a technical malfunction, a flux limit of 3×10^{-5} photons cm^{-2} sec^{-1} was obtained, comparable to those limits set by previous detector systems. (auth)

27275 RADIO OBSERVATIONS OF SEVEN SUGGESTED SUPERNOVA REMNANTS. Milne, D. K. (Commonwealth Scientific and Industrial Research Organization, Sydney). Proc. Astron. Soc. Aust., 1: 93-4(Feb. 1968). (RPP-1160/4).

Aizu and Tabara (1967) listed 36 radio sources classified as supernova remnants (SNR). Some of the identifications were based on low-resolution radio data and are consequently unreliable. Using the Parkes 210-foot telescope at 635, 1410, and 2650 MHz seven of these sources were observed. Of these, there is close agreement with Aizu and Tabara's data only for 3C 396.1, and the author agrees with the SNR classification, with certain reservations, for only three of these sources. (W.D.M.)

27276 A SEARCH FOR GAMMA RAY EMISSION FROM SUPERNOVA REMNANTS AND ITS RELATION TO THE ORIGIN OF COSMIC RAYS. May, Thomas Clifford. Minneapolis, Univ. of Minnesota, 1968. 150p.
Thesis.

A high-altitude balloon flight experiment has been built and flown which can resolve a lower flux of gamma rays (E > 200 MeV) from a celestial object, than any other experiment performed to date. The basic elements of the apparatus are nuclear emulsions, spark chambers, a gas Cherenkov counter, and numerous scintillation counters. This thesis first discusses the physical significance of future observations of gamma rays from the supernova remnants, Cassiopeia A and the Crab Nebula. If supernova remnants are the origin of galactic cosmic rays, Cassiopeia A could be emitting a detectable flux of high-energy gamma rays. An observation of a gamma ray flux from Cassiopeia A would be in fact a measure of the product of nebular mass and total energy of cosmic rays contained in the nebula. A detectable gamma-ray flux from the Crab Nebula would most likely be produced by the inverse Compton-synchrotron process. Such a measurement of a flux would be a measure of the average magnetic field strength in the nebula. The description of the experimental apparatus is presented followed by a presentation of the results of the first attempt to fly the apparatus. A partially successful flight was made which produced a 20 minute rather than a full 3 hour observation of Cassiopeia A. An upper limit to the gamma-ray flux of 3×10^{-5} photons/cm^2 sec was established. Although this value is not as low as the ultimate capability of the apparatus, it is one of the lowest limits established to date. The flux limit, with certain assumptions, sets an upper limit on the product of the mass and cosmic-ray energy product in the nebula of 6×10^{53} ergs $M_{\odot}$. As well as setting an upper limit, the flight demonstrated the feasibility of the experimental procedure and indicated the gamma-ray fluxes that can be resolved in the near future. (Disser. Abstr.)

27277 SIMULTANEOUS OPTICAL AND RADIO OBSERVATIONS OF NP 0532. Conklin, E. K. (Stanford Univ., Calif.); Howard, H. T.; Miller, J. S.; Wampler, E. J. Nature (London), 222: 552-3(May 10, 1969).

The observations presented were obtained at Lick Observatory and Stanford University on March 13 and 15, 1969. The data indicate that, after correction for interstellar dispersion, the optical and radio pulses are emitted simultaneously (with a time uncertainty of ±6 ms arising almost entirely from uncertainty in the value of the instellar dispersion). Observations of optical pulses were made with the 120-in. telescope at Lick, employing a photomultiplier operated at the prime focus, in conjunction with a multichannel analyser, and trigger signals were transmitted to the 150-ft paraboloid at Stanford 48 km to the west, and similarly analysed with regard to 424 MHz radio pulses. Synchronisation was to ±50 μsec over any period of 1 hr after compensation for travel time and other systematic effects. The optical pulses were measured in white light with a 5.5 arc S diaphragm, and the radio pulses were observed at 424 MHz with a bandwidth of 600 kHz. (UK)

27278 THE PERIOD OF PULSAR NP 0532. Richards, D. W.; Comella, J. M. (Arecibo Ionospheric Observatory, Puerto Rico). Nature (London), 222: 551-2(May 10, 1969).

Results of radio frequency pulse period measurements made at Arecibo are presented. Measurements were made with the 1,000-ft reflector, operating at frequencies of 196.5, 318, 320, 327, and 430 MHz. (UK)

27279 OPTICAL VARIATIONS IN QUASI-STELLAR OBJECTS. Peach, J. V. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Nature (London), 222: 439-42 (May 3, 1969).

Photometric observations of thirty quasi-stellar objects were made and seven new variables discovered. No correlation was found, however, between variability and any other observed property. (auth) (UK)

27280 CRAB AND VELA PULSARS. Freeman, K. C.; Rodgers, A. W.; Rudge, P. T. (Australian National Univ., Canberra). Nature (London), 222: 459-60(May 3, 1969).

Optical observations of the Vela pulsar PSR 0833-45, and measurements of linear and circular polarisation in the Crab pulsar NP 0532, were attempted using a 74-inch telescope. The experimental setup and its method of operation are described. From the results, it is concluded that the Vela pulsar has a visible brightness fainter than 21.5 magnitude, and that the optical radiation from the Crab pulsar is probably less than 25% circularly polarised. (UK)

Solar Phenomena

Refer also to abstracts 26609, 27408, 27426, 27447, 27460, 27478, and 27492.

27281 (AD-674267) SOLAR FLARES. Sturrock, P. A. (Stanford Univ., Calif. Inst. for Plasma Research). May 8, 1968. Contract AF49(638)-1321. 20p. (AFOSR-68-1750). CFSTI.

A solar flare is, intrinsically, a very complex phenomenon. When the complexities of the observational techniques and data-analysis methods make themselves felt, the solar astrophysicist must finally deal with a situation that may be likened to the Gordian knot. It is clear, therefore, that any theory that attempts to explain the whole range of flare phenomena will be very involved. For that reason alone, it will be extremely difficult to formulate a complete theory of solar flares. A fruitful approach to the problem might be to formulate a simple but reasonable physical model, calculate its properties, and understand their implications, and then compare the results with observations. Obviously, there has to be a common meeting ground and considerable interplay between the observers and the theoreticians to obtain models of the physical phenomena that are both relevant and tractable. (auth) (USGRDR)

27282 (AD-674272) FORCE-FREE MAGNETIC FIELDS AND SOLAR FILAMENTS. Sturrock, P. A.; Woodbury, E. T. (Stanford Univ., Calif. Inst. for Plasma Research). May 8,

1968. Contract AF49(638)-1321. 15p. (SU-TPR-103; AFOSR-68-1824). CFSTI.

There is ample motivation for considering the properties of force-free magnetic field configurations in solar astrophysics. Above a certain height in the atmosphere of the Sun the magnetic pressure so dominates the kinetic pressure of the highly conducting plasma that there is no possibility of balancing the $j \times B$ force unless the currents align themselves along the magnetic lines of force. Strictly speaking, of course, field configurations can never be wholly force-free; but there is a wide range of interesting cases in which this idealization is a very good approximation to reality. (auth) (USGRDR)

27283 (AD-677729) THE SUN, SOLAR PHENOMENA, AND THEIR ALLIED EFFECTS, INCLUDING THE EARTH'S MAGNETIC FIELD AND RADIATION BELTS: A SELECTED BIBLIOGRAPHY, 1958-1961. Benedict, R. F. (General Dynamics/Astronautics, San Diego, Calif.). Apr. 1961. 51p. (GDA-AE-61-0002-3). CFSTI.

The bibliography includes articles on the Sun, solar phenomena, Earth's magnetic field, and radiation belts, etc. (USGRDR)

27284 (AD-678101) THE ELECTRIC FIELD IN THE SOLAR CORONAL EXOSPHERE AND THE SOLAR WIND. Environmental Research Papers No. 292. Sen, Hari K. (Air Force Cambridge Research Labs., L. G. Hanscom Field, Mass.). Oct. 1968. 17p. (AFCRL-68-0506). CFSTI.

The solar coronal exosphere (fixed at a level where the mean free path is comparable with the scale height) is shown to act like the sheath in a laboratory discharge, that builds up an excess positive charge and electric field. Equality of flux for the charged particles (protons and electrons) at the exosphere is assumed. The value of exospheric electric potential makes the protons virtually weightless. The exospheric sheath potential accelerates the thermal protons to a velocity of 258 km/sec, with which they coast to the Earth. The proton density in transit varies approximately as the inverse square law. Higher velocities and densities are obtained for higher coronal temperatures. An estimate of the exospheric transition region is obtained by applying the hydrodynamic theory of ambipolar diffusion in a gravitational field to the observed coronal density distribution. (auth) (USGRDR)

27285 (AD-678442) TWO PROMINENCE ERUPTIONS AND THE PROBLEM OF EMISSION. Technical Report, January 15-29, 1968. Zirin, Harold (Palomar Observatory, Pasadena, Calif.). Oct. 1968. Contract N00014-67-C-0140. 21p. (TR-2). CFSTI.

Two eruptions on January 15 and 29, 1968, not associated with flares, are discussed. The first is a filament which turns bright and erupts upward, reappearing an hour later. The second is a large eruptive arch seen against the disk. The arch is bright at the top of its trajectory, turns dark, but produces chromospheric emission at the point of impact. The emission at the top of the arch is ascribed to the velocity shift of the illuminating chromospheric Hα line. It is shown that such emission will occur only if the motion is transverse to the line of sight and the prominence is optically thin. (auth) (USGRDR)

27286 (AD-679212) MICROWAVE OBSERVATIONS AND SOME IONOSPHERIC EFFECTS DURING NOVEMBER 12, 1966 TOTAL SOLAR ECLIPSE. Report No. 2 (Final), June 1966-August 1968. Kaufmann, Pierre (Universidade Mackenzie, Sao Paulo (Brazil). Grupo de Radio-Astronomia). 19p. (GRAM-29). CFSTI.

Radio observations of the Sun with a 4.28-cm radio polarimeter were performed during the November 12, 1966, total solar eclipse at a site located near the city of Bage, in the extreme south of Brazil. The solar activity during that period is discussed, giving additional data for the eclipse measurements themselves. (auth) (USGRDR)

27287 (AD-681369) BASIC SOLAR RESEARCH. Annual Report, January 1-December 31, 1968. Mohler, O. C. (Michigan Univ., Ann Arbor. Dept. of Astronomy). Dec. 1968. Contract Nonr-1224(19). 7p. CFSTI.

The report from the McMath-Hulbert Observatory contains a number of studies concerned with solar activity, solar flares, solar-terrestrial relationships, solar spectroscopy, and applications of hydromagnetic theory to the Sun. Brief summaries of certain of these investigations are given. (USGRDR)

27288 (N-69-10668) ELECTRONS AND PROTONS IN LONG-LIVED STREAMS OF ENERGETIC SOLAR PARTICLES. Anderson, K. A. (California Univ., Berkeley. Space Sciences Lab.). June 1968. 45p. (NASA-CR-97611). CFSTI.

In 1966 and 1967 many long-lived streams of low-energy solar electrons and protons were observed near Earth. These streams were sometimes associated with bright flares which occurred many hours earlier and sometimes no individual flare could be found. The long-lived solar events discussed here include energetic storm particles, delayed events, and fluxes associated with solar active regions. It is suggested that these are all probably the same basic phenomena viewed in somewhat different ways depending on the age of the region and its location on the solar disc. These events are usually associated with a depression in the sea-level neutron intensity and one or more sudden commencements or sudden impulses. Both electrons and protons are present in these events but in several cases electrons were not detected. The most unusual feature is that when both particle species are present, the electron flux is centered several hours before the proton flux. (auth) (STAR)

27289 (N-69-10670) THE SOLAR PARTICLE EVENTS OF MAY 23 AND MAY 28, 1967. Lindgren, S. T. (California Univ., Berkeley. Space Sciences Lab.). Feb. 1, 1968. Contracts NAS5-9077; NAS5-9091. 55p. (NASA-CR-97607). CFSTI.

McMath plage region 8818 passed over the visible solar disk on May 17-31, 1967. Although it was very active from its first appearance on the eastern limb, no solar particles could be detected near the Earth until the evening of May 23, when three bright flares were observed in close succession at 25° to 28°E. During the following buildup of the solar particle flux over ≈ 36 hours, the galactic cosmic-ray flux >1 BeV decreased gradually by about 5%. A later particle event early on May 28 was also associated with a bright flare in McMath region 8818 at 33°W. This event displayed a rapid buildup, with electrons arriving first, and an exponential decay. A smooth proton peak, 20 minutes wide, was detected on May 30 closely associated with an SSC attributed to plasma ejection from the parent flare of the May 28 event. Between the geomagnetic storms beginning on May 25 and May 30 an anomalous daily variation was observed in the cosmic-ray flux >1 BeV, the time of maximum falling 7 to 10 hours earlier than normal. (auth) (STAR)

27290 (N-69-10867) MAGNETIC STRUCTURE OF SUNSPOT GROUPS WHICH PRODUCE SOLAR PROTON FLARES. Sakurai, Kunitomo (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Sept. 1968. 19p. (NASA-TM-X-63383; X-615-68-384). CFSTI.

Solar proton flares take place due to the release of magnetic energy accumulated within the sunspot magnetic flux tube of force lying in the chromosphere and the lower corona due to the twisting of it, which is seen from the rotational motion of sunspot groups on the photospheric surface. This rotational motion is counterclockwise (clockwise) in the northern (southern) hemisphere when viewed from the Earth. The accumulation of magnetic energy within the flux tube due to this motion continues to proceed until some instability is induced along the flux tube. It is further shown that the magnetic configuration of sunspot groups is important for the triggering of a solar proton flare. (auth) (STAR)

27291 (N-69-11372) SOLAR PROTON FORECAST SYSTEM AND PROCEDURES USED DURING THE MARINER 5 MISSION. Gonzalez, Charles C.; Divita, Edward L. (Jet Propulsion Lab., Pasadena, Calif.). Oct. 1, 1968. Contract NAS7-100. 44p. (NASA-CR-97807; JPL-TR-32-1303). CFSTI.

A solar forecasting system and forecasting procedures for predicting the time of occurrence of solar proton events and the associated time integrated proton flux on a real time basis for the Mariner 5 mission are discussed. The solar forecasting system utilizes solar activity data obtained from solar observational networks and provided by the Space Disturbance Forecast Center (SDFC) at Boulder, Colorado. Since SDFC does not provide forecast of proton events and their sizes on a real-time basis, statistical methods are developed, based on past solar cycle data, in order to use the solar activity data obtained on a real-time basis in predicting proton events and their sizes. The 2800-MHz radio burst energy is correlated with time integrated proton flux. Several other solar parameters are correlated with time integrated proton flux. However, none results in a better correlation. In addition, procedures for receiving data, making forecasts, and reporting the forecasts to the project on a real time basis are described. Statistical uncertainties in the prediction method and uncertainties in the data are discussed, and their influence on the value of the predictions is evaluated. A brief history of the real time forecasting of proton events using the method and procedures is presented. (auth) (STAR)

27292 (N-69-11448) MAGNETO-GRAVITY WAVES AND THE HEATING OF THE SOLAR CORONA. McLellan IV, Alden; Winterberg, F. (International Centre for Theoretical Physics, Trieste (Italy)). Jan. 1968. 17p. (NASA-CR-97722; IC-68/10). CFSTI.

It is generally believed that the heating of the solar corona is caused by waves originating in the photosphere and propagating into the corona where their energy is dissipated. The medium through which these waves propagate is in general permeated by magnetic fields complicating the behavior of this propagation considerably. Wave motions in a plasma permeated by constant magnetic and gravitational fields were analyzed. In general, three wave modes were found, each of them strongly coupled to each of the three kinds of motion; acoustic, gravity, and hydromagnetic. However, the Alfvén mode was found to be separable from the dispersion relation and therefore independent of compressibility and gravity. The local dispersion relation is derived and expressed in nondimensional form independent of the constants that describe a particular atmosphere. From the dispersion relation one can show that rising waves propagate either with a constant or a growing wave amplitude depending on the magnitudes and directions of the gravitational field, magnetic field, and the wave vector. The variation of the density with height is taken into account by a generalized W.K.B. method. Equations are found which give the height at which wave reflection occurs, giving the upper bound for possible wave propagation. (auth) (STAR)

27293 (N-69-15555) MICROWAVE AND HARD X-RAY BURSTS FROM SOLAR FLARES. Holt, Stephen S.; Ramathy, Reuven (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Dec. 1968. 52p. (NASA-TM-X-63433; X-611-68-497). CFSTI.

Detailed theories of gyro-synchrotron emission and absorption in a magnetoactive plasma, x-ray production by the bremsstrahlung of nonthermal electrons on ambient hydrogen, and electron relaxation in a partially ionized and magnetized gas are applied to the solar-flare burst phenomenon. The hard x-ray and microwave bursts are shown to be consistent with a single source of nonthermal electrons, where both emissions arise from electrons with energies $<mc^2$. Furthermore, the experimental x-ray and microwave data allow deduction of electron distribution properties, values of the ambient magnetic field, hydrogen density, and size of the emitting region. The proposed model, although derived mostly from observations of the July 7, 1966 flare, is shown to be representative of this type of event. (auth) (STAR)

27294 (N-69-15692) CORRELATION OF A SOLAR FLARE WITH A VISUAL AURORA. Meriwether, J. W. Jr.; Benesch, W. M.; Tilford, S. G. (Maryland Univ., College Park. Inst. for Molecular Physics). [Feb. 1968]. 27p. (NASA-CR-99119). CFSTI.

On February 13, 1967 at 1746 UT, the brightest flare of that year erupted from the surface of the Sun. Approximately 56 hours later, the sudden commencement of a magnetic storm was recorded by many observatories around the world. Midway between the worldwide sudden commencement and the termination of the magnetic storm, there occurred at Ft. Churchill an aurora attaining nearly IBC III and an accompanying local negative magnetic bay. Measurements were made on this aurora as one of a series investigated with a multiple-channel photometer simultaneously recording ten wavelength bands. A detailed examination of its emission structure has turned up a number of deviations from other aurorae studied. These include an unusual amount of λ6300 intensity and an increase in the apparent vibrational temperature of the molecular nitrogen that correlates well with the increase in the λ6300 emission. (auth) (STAR)

27295 (N-69-17934) TYPE 3 RADIO BURSTS IN THE OUTER CORONA. Alexander, J. K.; Malitson, H. H.; Stone, R. G. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Nov. 1968. 25p. (NASA-TM-X-63403; X-615-68-442). CFSTI.

Type-III solar radio bursts observed from 3.0 to 0.45 MHz with the ATS-II satellite over the period April to October 1967 were analyzed to derive two alternative models of active region streamers in the outer solar corona. Assuming that the bursts correspond to radiation near the electron plasma frequency, pressure equilibrium arguments lead to streamer Model I in which the streamer electron temperature derived from collision damping time falls off much more rapidly than in the average corona and the electron density is as much as 25 times the average coronal density at heights of 10 to 50 solar radii. In Model II the streamer electron temperature is assumed to equal the average coronal temperature, giving a density enhancement which decreases from a factor of 10 close to the Sun to less than a factor of two at large distances (>¼ AU). When the burst frequency drift is interpreted as resulting from the outward motion of a disturbance that stimulates the radio emission, Model I gives a constant velocity of about 0.35c for the exciting disturbance as it moves to large distances, while with Model II, there is a decrease in the velocity to less than 0.2c beyond 10 solar radii. (auth) (STAR)

27296 (N-69-17978) HYDROMAGNETIC SHOCKS IN THE SOLAR WIND. Ogilvie, K. W.; Burlaga, L. F. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Jan. 1969. 24p. (NASA-TM-X-63449; X-616-69-29). CFSTI.

The Rankine–Hugoniot relations are applied to shock-like discontinuities measured by both magnetic field and plasma instruments on the satellite Explorer 34 between May 30, 1967 and January 11, 1968. Shock normals were either determined from the magnetic field observations, or from the times of occurrence of the discontinuity at Explorers 33, 34, and 35. The Rankine–Hugoniot relations are obeyed to the accuracy of the observations, and the values of shock velocities, density ratios, and Mach numbers indicate that at 1 AU the typical interplanetary shock is not strong, although all the events studied caused geomagnetic impulses. (auth) (STAR)

27297 ORIGIN OF LIGHT ELEMENTS IN THE SOLAR SYSTEM. Hayakawa, Satio (Nagoya Univ., Japan). Progr. Theor. Phys. (Kyoto), Suppl. Extra No., 156-69(1968).

The abundances of light elements, Li, Be and B are explained as nuclear reaction products caused by high-energy particles accelerated in the early stage of the Sun. The theory developed in the present paper is at variance with that by Fowler, Greenstein, and Hoyle in such a respect that neutron-capture processes are not important. The present theory is an extention of the theories proposed earlier by the present author and by Bernas et al., but is different from them in such a respect that nuclear reactions induced by α particles are taken into account. This increases the Be/B ratio so as to agree with the meteoritic ratio. The α–He collisions produce Li isotopes on the solar surface, and they are transported as solar wind into interplanetary space to be mixed with planetary primordial matter. This increases the Li/Be ratio, so that the meteoritic abundances are roughly reproduced, if the depletion of ^{6}Li takes place at the bottom of the solar convection zone. (auth)

27298 ON PROBLEMS, TASKS, AND WORKING AIDS IN SOLAR RESEARCH. Jaeger, Friedrich Wilhelm. Jena Rev., No. 6, 326-9(1968).

The methodological situations in investigating the quiet Sun and active Sun are briefly outlined. The instruments and methods used in research on these problems are discussed. (W.D.M.)

27299 RADIO INVESTIGATION OF THE SOLAR PLASMA. Hewish, A.; Symonds, M. D. (Cambridge Univ., Eng.). Planet. Space Sci., 17: 313-20(Mar. 1969).

Observations of interplanetary scintillation and of the angular spectrum of radio waves scattered by the solar plasma are discussed. The scintillation index is found to vary as $(\text{distance})^{-1.6}$ in the range 0.1 to 1.5 AU and the scale of the plasma irregularities is derived in the range 0.1 to 1.0 AU. Scintillation observed in the anti-solar direction gives no indication of a magnetospheric tail. Data obtained in 1967 show no enhancement of the solar wind at high heliocentric latitude. (auth) (UK)

27300 SPONTANEOUS SINGLE-PHOTON DECAY OF 2 $^3S_1$ IN HELIUM-LIKE IONS. Griem, Hans R. (Culham Lab., Abingdon, Eng.). Astrophys. J., 156: L103-5(May 1969).

Transition probabilities for 1 $^1S_0$–2 $^3S_1$ lines in helium-like ions are estimated from hydrogen 1 $^2S_{1/2}$–2 $^2S_{1/2}$ magnetic-dipole transition probabilities obtained by Breit and Teller from Dirac theory. For C v and higher members of the isoelectronic sequence the new transition rates are sufficiently large (when compared with collisional rates) to explain the strong emission of these lines by the corona and to make two-photon decay negligible for $Z \lesssim 20$. (auth)

27301 SENSITIVITY OF THE SOLAR-NEUTRINO FLUXES. Bahcall, John N.; Bahcall, Neta A.; Ulrich, Roger K. (California Inst. of Tech., Pasadena). Astrophys. J., 156: 559-68(May 1969).

The sensitivity of the solar-neutrino fluxes to localized changes in the opacity and the equation of state is calculated. The sensitivity to changes in the equation of state reaches a maximum near 8×10^6°K and is in general much larger than the sensitivity to opacity changes. The effect of various parameters on the predicted rate of neutrino capture in the ^{37}Cl experiment is summarized. The characteristic numerical properties of a standard solar model are then presented. Several general conclusions are justified on the basis of the variations considered. In particular, an assessment is given of the relation between the theory of solar models and the experimental results of Davis, Harmer, and Hoffman. (auth)

27302 COMPUTED PROFILES FOR SOLAR Mg b- AND Na D-LINES. Athay, R. Grant; Canfield, Richard C. (High Altitude

Observatory, Boulder, Colo.). Astrophys. J., 156: 695-706(May 1969).

Profiles are computed for the Doppler cores of solar Mg b- and Na D-lines for multilevel model atoms and for selected ranges of chromospheric parameters. Comparison of computed and observed profiles from center to limb on the solar disk yields the depth variation of the horizontal and vertical components of microturbulence. The two components are found to be of unequal amplitude for $\tau_c > 10^{-5}$ and pass through minima near $\tau_c = 10^{-5}$. The profiles also suggest that $n_e(\tau_c)$ at $\tau_c = 10^{-4}-10^{-6}$ obtained from eclipse data is more reasonable than that of the Bilderberg model. (auth)

27303 THERMAL GENERATION OF HYDROMAGNETIC WAVES IN SUNSPOTS. Savage, Blair D. (Princeton Univ. Observatory, N. J.). Astrophys. J., 156: 707-29(May 1969).

Calculations on the hydromagnetic stability of a thermally unstable layer traversed by a vertical magnetic field with open boundary conditions have been extended to include the effect of hydromagnetic wave reflection due to a rapidly decreasing density with height above the layer. The wave reflection is studied by determining the effect of standing surface gravity waves arising from a density discontinuity at the boundary of a superadiabatic layer and an adiabatic region above. For parameters characteristic of solar magnetic regions, the presence of gravity waves tends to close the boundaries and therefore reduces the threshold for emission of hydromagnetic waves by overstable oscillations in the layer. Applying the stability calculations to two recent umbral models of Yun it is found that overstable oscillations and hence thermal hydromagnetic wave generation will likely occur in sunspots. (auth)

27304 CORONAL ENHANCEMENT IN THE EXTREME ULTRAVIOLET. Boardman, W. J.; Billings, D. E. (Univ. of Colorado, Boulder). Astrophys. J., 156: 731-8(May 1969).

A photometric study of a coronal limb enhancement recorded on the NRL spectroheliograms of April 28, 1966, is described. The wavelength region of 170 to 630 Å included lines from the ions Fe IX, XIV, XV, and XVI, Ne VII, Mg IX, and Si XII that were strong enough to allow useful photometry. A comparison of the maximum brightnesses of the enhancement in these lines indicates an increase in the amount of radiating material up to temperatures as high as 4 to 5 million degrees, followed by a sharp decrease. A more detailed study of the brightness profiles of the feature in lines of different temperatures indicates that the hotter material ($3 \times 10^{6}\,^{\circ}$K) is confined to a dense "core" of about 20,000 km height and 30,000 km radial distance from an assumed axis of symmetry. In the hottest part of the enhancement, maximum rms electron densities of 2×10^{-9} cm^{-3} were reached. (auth)

27305 PHYSICAL PROPERTIES OF 5303 A CORONAL EMISSION REGIONS. Billings, Donald E.; Joselyn, Jo Ann (Univ. of Colorado, Boulder). Astrophys. J., 156: 739-51(May 1969).

Two enhancements of the coronal green line were analyzed from repeated graded-height spectrograms. For one enhancement, the data may be interpreted either by a model in which temperature increases with height throughout the lower corona, or by one in which the temperature decreases with height, both models leading to reasonable density distributions. Implications concerning the motion field in either case were considered. The other enhancement can be interpreted by introducing a slightly perturbed potential magnetic field. (auth)

27306 SOFT X-RAY OBSERVATIONS FROM OSO-4. Culhane, J. L.; Sanford, P. W.; Phillip, K. J. H. (University Coll., London). Sky Telesc., 37: 287; 298(May 1969).

An experiment is described which employs an array of proportional counters that detects soft x-ray photons in the wavelength bands 1 to 3, 3 to 9, 8 to 18, and 44 to 60 Å. The brief analysis presented used data from two orbits a day out of the 15 that the satellite makes. (W.D.M.)

27307 TRANSPORT COEFFICIENTS IN THE CHROMOSPHERE AND CORONAL GAS. II. THERMAL CONDUCTIVITY. Delcroix, A.; Lemaire, A. (Institut d'Astrophysique, Cointe-Sclessin, Belg.). Astrophys. J., 156: 787-90(May 1969).

The coefficient of thermal conductivity is of major importance, mainly in the solar corona and chromosphere, in evaluating the corresponding flux of energy transported by conductivity. The values of the coefficient of thermal conductivity were computed using Devoto's (1966) expressions for the first to the fourth approximations of the Chapman–Enskog series. (W.D.M.)

27308 TURBULENT VELOCITIES IN THE SOLAR ATMOSPHERE. Kuli-Zade, D. M. Uch. Zap. Leningrad. Gos. Univ., No. 337, Ser. Mat. Nauk, No. 42, 46-53(1968). (In Russian).

The velocities of the turbulent motions in the solar photosphere were found by three methods. Using the curves of correlation, it was found that the velocities of the microturbulent motions increase from the center to the limb of the solar disc. The velocity of the macroturbulent motions as defined from the central depths of the Fraunhofer lines is equal to 2.21 km/sec at the center of the disc and to 2.18 km/sec at the limb. The study of line profiles leads to the conclusion that for $0.0 < \tau_0 < 0.2$ the velocities of the turbulent (macro+micro) motions ν_{mM} decrease when τ_0 increase. At large optical depths ν_{mM} increases with the depth. (auth)

27309 THE NORTH–SOUTH ASYMMETRY OF CHROMOSPHERIC FLARES FOLLOWED BY CORPUSCULAR GEOPHYSICAL EFFECTS, SSC. Popovici, Calin; Maris, Georgeta (Observatorul Astronomic, Bucharest). Stud. Cercet. Astron., 13: 3-9(1968). (In Rumanian).

A method is given to decide if such an asymmetry is caused by the flare asymmetry occurrence on the Sun, or some influence of the Sun–Earth transmission conditions. The probabilistic model used gives the possibility to calculate the probability of corpuscular emission and the modified transmission condition if there are some double events: flare with SSC, followed by flare with or without SSC. This procedure can be applied to both solar hemispheres. An application of the method to the list of Caroubalos and the statistics of Bell for all the flares followed by SSC (without taking into account the intensity of the SSC) shows that the asymmetry of the flares followed by SSC is explained by the general asymmetry of the solar activity in the period considered. As for great-storm flares, or for those producing GLE, PCA, Forbush effects, for which the N–S asymmetry is more pronounced, the authors are of the opinion that the causes must be searched for on the Sun and not in some Sun–Earth transmission conditions. (auth)

27310 DYNAMICS OF CHARGED INTERPLANETARY GRAINS. Standeford, Leo Vern. Urbana, Ill., Univ. of Illinois, 1968. 140p.
Thesis.

The purpose of the present investigation is to determine whether the Lorentz force on charged grains moving in solar orbits can change their orbital inclinations sufficiently to explain the observed distribution. Since the expected life-time of a grain is important in assessing the net change in its orbital inclination, the reduction in the semi-major axis and eccentricity of its orbit arising from drag forces produced by solar radiation pressure, wind pressure, and the Coulombic force due to passing solar wind electrons and protons have also been examined. The latter investigation has shown that these forces will cause a grain of radius one micron to spiral from the Earth's distance into the Sun in only a few centuries. This interval of time, including the effects of the solar wind, is less by about a factor of five than earlier computations dealing only with the drag effects of solar radiation, the so-called Poynting–Robertson effect. (Disser. Abstr.)

27311 CHARACTERISTICS OF THE SOLAR WIND NEAR THE ORBIT OF JUPITER. Scarf, Frederick L. (TRW Systems Group, Redondo Beach, Calif.). Planet. Space Sci., 17: 595-608(Apr. 1969).

It is assumed that the solar-wind flow out to at least 5.2 AU is adiabatic, with no change in streaming speed, and near Earth observations are extrapolated to determine the plasma characteristics in the distant interplanetary medium. It is shown that at the orbit of Jupiter, electron plasma oscillations and electron whistlers have distinct and novel characteristics; the high frequency electromagnetic waves will be unstable in the wind if $T_{\parallel}^{(-)} < T_{\perp}^{(-)}$, and the wind flow will be supersonic with respect to electron plasma oscillations when the electrons are sufficiently cool. Both of these conditions arise if the expansion is strictly adiabatic. Near Jupiter, the large gravitational field can distort the particle distribution functions well beyond the conventional shock boundary, and it is conjectured that a low-frequency drift instability associated with ion sound waves may also be significant in the upstream solar wind. (auth) (UK)

27312 SOLAR X-RAY FLUX DEDUCED FROM FLARE EFFECTS ON VLF PROPAGATION. Barletti, R.; Tagliaferri, G. L. (Osservatorio Astrofisico di Arcestri, Florence). J. Atmos. Terrest. Phys., 31: 631-9(May 1969).

A method is described to evaluate the spectral distribution in the 0.3- to 3-Å region of the solar radiation during flare by means of the amplitude and phase variations induced in a vlf radio link. Some events were studied and the results are compared with the available solar data. (auth) (UK)

Galaxies

Refer also to abstracts 27243, 27270, and 27407.

27313 EXTRAGALACTIC RESEARCH. Bronkalla, Werner; Oleak, Hans; Treder, Hans-Juergen; Notni, Peter (Babelsberg Observatory, Berlin). Jena Rev., No. 6, 322-5(1968).

The properties of galaxies are considered and possible areas of optical research are pointed out. Quasars and blue stellar objects are briefly mentioned. (W.D.M.)

27314 MESSIER 87: THE GALAXY OF GREATEST KNOWN MASS. Brandt, John C.; Roosen, Robert G. (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J., 156: L59-61(May 1969).

The velocity dispersion of the nucleus of Messier 87 was determined by the method of Burbidge, Burbidge, and Fish. A mass of 2.7×10^{12} $M_\odot$ was calculated from the virial theorem, yielding a mass-to-light (photographic) ratio of 85. (auth)

27315 ROTATION AND MASS OF THE GALAXY NGC 6574. Demoulin, Marie-Helene; Chan, Y. W. Tung (Univ. of California, San Diego). Astrophys. J., 156: 501-8(May 1969).

NGC 6574 is an Sc galaxy of high surface brightness. The spectra show emission lines which are discontinuous in the central regions of the galaxy. The rotation curve has a steep gradient within a radius of 640 pc and then is almost flat over 1900 pc. The mass of NGC 6574 is 4×10^{10} $M_\odot$; the M/L ratio is 1.6; these values are in agreement with those found for other Sc-type systems, but NGC 6574 is a relatively massive and bright object among the Sc galaxies. There may be some indications of a difference of 85 km sec^{-1} between the velocity of the nucleus and the systemic velocity. (auth)

27316 RELATIVISTIC, SPHERICALLY SYMMETRIC STAR CLUSTERS. II. SUFFICIENT CONDITIONS FOR STABILITY AGAINST RADIAL PERTURBATIONS. Ipser, James R. (California Inst. of Tech., Pasadena). Astrophys. J., 156: 509-27(May 1969).

In Paper I of this series necessary and sufficient conditions were developed for the stability against radial perturbations of spherically symmetric, collisionless, relativistic star clusters. Those conditions are difficult to apply because they involve analyses in two or more dimensions. This paper presents much simpler, one-dimensional, sufficient (but not necessary) criteria for the stability of relativistic clusters. These criteria are relativistic generalizations of Newtonian criteria developed by Lynden-Bell and Sanitt. The most important new criterion is this: A bounded, relativistic, spherical star cluster with isotropic velocity distribution is stable against small radial perturbations, if the gas sphere with the same distribution of density and pressure is stable against radial perturbations with adiabatic index $\Gamma_1 = (\rho + p)p^{-1} (dp/dr)(d\rho/dr)^{-1}$. (auth)

27317 HIGH-VELOCITY CLOUD COMPLEXES AS EXTRAGALACTIC OBJECTS IN THE LOCAL GROUP. Verschuur, G. L. Astrophys. J., 156: 771-7(May 1969).

The high-velocity clouds may be matter in the Local Group of galaxies that has not contracted to galactic dimensions or densities. Intergalactic matter elsewhere might be similarly inhomogeneous. (auth)

27318 INFRARED OBSERVATION OF THE GALACTIC CENTER. Becklin, Eric Edward. Pasadena, Calif., California Inst. of Tech., 1968. 126p.

Thesis.

Infrared radiation from the nucleus of the Galaxy has been detected at effective wavelengths of 1.65, 2.2, 3.4, and 4.8 μ with angular resolutions from 0.04 to 1.8 arc min. Observations have been made over an area of 1 square degree surrounding the dynamical center of the Galaxy. The reduced data consist of contour maps of the 2.2-μ brightness distribution of the galactic center region for resolutions of 1.8, 0.8, and 0.25 arc min, and of tabulations of the 1.65, 2.2, 3.4, and 4.8 μ flux densities and surface brightnesses at various areas in the galactic center region. From the brightness distribution maps it is found that the structure consists of: (1) a dominant source 5 arc min in diameter, (2) a point-like source centered on the dominant source, (3) an extended background approximately 1 degree in diameter, (4) additional discrete extended sources which are fainter than the dominant source. A comparison of the infrared and radio observations shows that the dominant infrared source and the radio source Sagittarius A have the same coordinates and similar sizes. An analysis of the observed infrared radiation predicts about 25 magnitudes of visual absorption between the Sun and the galactic center if the source of infrared radiation is stellar. A comparison is also made between the infrared radiation from the galactic center and that from the nucleus of M31 which shows agreement in both the apparent structure and infrared luminosity of the two nuclei. (Disser. Abstr.)

27319 TURBULENT PRODUCTION OF A GALACTIC FIELD. Fitremann, Maryvonne; Frisch, Uriel (Institut d'Astrophysique, Paris). Compt. Rend., Ser. B, 283: 705-8(Mar. 3, 1969). (In French).

The evolution of a magnetic field in an infinitely conducting turbulent fluid is studied. When the turbulence is not (statistically) invariant in the symmetry plane, there is the appearance of magnetic structures of a very much higher scale than the length of the turbulent correlation. Some applications are considered. In particular, a model for the galactic magnetic field is obtained. (tr-auth)

Cosmology

Refer also to abstracts 27396 and 27865.

27320 (AD-678054) RELATIVITY AND COSMOLOGY. Final Scientific Report. Robertson, H. P.; Noonan, T. W. (North Carolina Univ., Chapel Hill. Dept. of Physics). Oct. 1968. 490p. W. B. Saunders Co., Philadelphia, Pa. $16.50.

Relativity and Cosmology are a presentation of the fundamentals of special relativity, general relativity, and cosmology, with particular emphasis and development of (1) the electromagnetic stress—energy tensor in special relativity, (2) the Poynting—Robertson effect, (3) the experimental basis for special-relativistic gravitational theories, (4) the geometric foundation for Reimannian geometry, (5) the derivation of the cosmological metric from group theory, (6) a discussion of cosmological models, (7) rotation of coordinate systems in general relativity, (8) electromagnetism in media in general relativity, (9) rotationally symmetric general-relativistic solutions, (10) Godel's cosmological model, and (11) geodesic precession. (USGRDR)

27321 (AD-678889) THE TWIN-EFFECT AND THE RED-SHIFT. Physical Sciences Research Papers No. 362. Post, E. J. (Air Force Cambridge Research Labs., L. G. Hanscom Field, Mass.). Oct. 1968. 23p. (AFCRL-68-0507). CFSTI.

The asymptotic relationship between twin-effect and acceleration redshift is discussed from a point of view of theory and experiment. The paradoxical aspects of the twin effect can be reduced to two major factors: (1) the detour paradox, which means that the world-line geodesic within the light cone gives a maximum path—hence detouring saves proper-time; (2) the assumption that proper-time is a characteristic measure for biological aging. A number of physical aging phenomena are then reviewed. Accepting the physical reality of the twin-effect of proper-time, one can then delineate two contributions to this effect: (1) the kinematical effect associated with uniform translational motion, and (2) the acceleration effect related to the redshift. The measurement of the acceleration redshift by Hay, et al., (1960) may be considered as an unambiguous confirmation of the twin-effect in which primarily the redshift contributes. No comparable check on the kinematical component is as yet available. In fact, experimentally it is not feasible to isolate the latter contribution. (auth) (USGRDR)

27322 MIXMASTER UNIVERSE. Misner, Charles W. (Univ. of Maryland, College Park). Phys. Rev. Lett., 22: 1071-4(May 19, 1969).

The generic, nonrotating, homogeneous cosmological model for a closed space (Bianchi type IX) has a very complex singularity which can, however, be described in detail. It appears that only the exceptional (previously studied) cases will have particle horizons. Thus these models may lead to some insight into how the broad-scale homogeneity of the universe may have been produced at very early times. (auth)

27323 EXPERIMENTAL TEST OF A GRAVITATIONAL EFFECT SUGGESTED BY SZEKERES. Shamir, J. (Technion-Israel Inst. of Tech., Haifa). Nature (London), 222: 362(Apr. 26, 1969).

Szekeres (Nature 220: 1116(1968)) suggested an interaction which causes an electromagnetic wave to change its frequency whilst travelling through a combination of electromagnetic and gravitational fields. In experimental work undertaken to examine this hypothesis a decrease in frequency of the 21-cm absorption line from Taurus A was observed when the line of sight approached the Sun. In a second experiment a decrease in the frequency of a terrestrial source was observed that was roughly proportional to distance. Szekeres suggested that this was a combined effect of the gravitational field and the transverse electric field of the Earth, and dependent on direction, a suggestion strengthened by evidence that the effect was not observed in two-way experiments. The present author describes a laboratory test for this hypothesis. Using a two-beam interferometer, a transverse electric field is applied to one of the beams, a beat should appear in the interference pattern. Using He–Ne laser light and such a transverse electric field the observed beat frequency did not agree with Szekeres' hypothesis. It may be that the effect also depends on the frequency of the electromagnetic wave, and is stronger for long wavelengths. (UK)

27324 TIME-SYMMETRIC ELECTRODYNAMICS AND SELF-ACTION. Pegg, D. T. (Clarenden Lab., Oxford). Nature (London), 222: 362-3(Apr. 26, 1969).

A reply is given to points raised by Hoyle and Narlikar (Nature 220: 893(1968)) concerning Pegg's alternative theory for spontaneous emission of radiation (Nature 220: 154(1968)). Pegg elaborates further on his proposed theory and indicates the reason for its introduction. Matters discussed include possible effects of electromagnetic zero point oscillations on emission rate; Pegg proposes a modification to the Hoyle–Narlikar absorber theory using the normally accepted association of zero point oscillations with classical self action. The proposed theory is, in effect, midway between an "absorber" and an "emitter" theory and introduces the time-symmetric concept. It is stated that the value of the proposed theory arises because, while being dependent on cosmology, it does not rely on any particular cosmological model, and will provide an explanation for spontaneous emission if the steady-state theory is disproved. The theory also retains the concept of electromagnetic mass, which appears important from high-energy scattering experiments. (UK)

27325 SEISMIC RESPONSE TO THE EARTH TO A GRAVITATIONAL WAVE IN THE 1-Hz BAND. Dyson, Freeman J. (Inst. for Advanced Study, Princeton, N. J.). Astrophys. J., 156: 529-40(May 1969).

The response of an elastic solid to an incident gravitational wave is calculated in the linearized approximation to general relativity. The response depends on irregularities in the shear-wave modulus, and is strongest at free surfaces. Calculations are carried through in detail, first for a stationary flat Earth and then for a spherical rotating Earth. The seismic response on a rotating Earth is split into five frequencies, ω, $\omega \pm \Omega$, $\omega \pm 2\Omega$, where ω is the frequency of the incident wave and Ω is the Earth's rotation frequency. The seismic signals expected from plausible theoretical models of pulsars are about a factor of 10^5 below prevailing noise levels, but the uncertainties in this estimate are so great that an attempt to detect pulsars seismically is not hopeless. (auth)

Planetary Phenomena

27326 (N-69-19320) FEASIBILITY STUDY OF LUNAR NEUTRON ALBEDO EXPERIMENT. Final Scientific Report. Haymes, Robert C. (Rice Univ., Houston, Tex. Dept. of Space Science). Jan. 1969. 31p. (NASA-CR-100256). CFSTI.

A feasibility study is made on the effect on the slow and fast neutron counting rates due to increases in water content. A lunar neutron simulator, consisting of neutron detectors and a fast neutron source, measures the effect of water concentration on the ratio using a basaltic material like that found on the Moon by the Surveyors. A sand–water mixture was also used in order to demonstrate the effects of differing elemental compositions in the sample. Data obtained using a 0.3% water content (by weight) in basalt indicate an increase of about 4% in the ratio over the 0.2% water content level. As expected from theory, the variation in ratio with water concentration is quite linear, for both samples tested. The only effect of variations in the elemental composition is to alter the slope of the line. (auth) (STAR)

Atomic and Molecular Physics

Atomic, Electron, Ion, and Molecular Beams and Their Reactions

Refer also to abstracts 26620, 26621, 27066, 27350, and 27687.

27327 ENERGY TRANSFER IN THE DE-EXCITATION OF $(H_3^+)^*$ BY H_2. Leventhal, J. J.; Friedman, L. (Brookhaven National Lab., Upton, N. Y.). J. Chem. Phys., 50: 2928-31 (Apr. 1, 1969).

Proton transfer from H_3^+ to H_2 has been investigated in a tandem mass-spectrometer system. Evidence for efficient de-excitation of H_3^+ in approximately one collision has been obtained by study of threshold for collision-induced dissociation of D_3^+ and reactions in the $H_3^+-C_2H_2$, $H_3^+-C_2H_4$, and $H_3^+-CH_4$ systems. The results suggest a transfer mechanism that leaves behind as product an excited neutral hydrogen molecule containing most of the internal energy of the original triatomic molecular ion. (auth)

27328 ENERGY LOSS AND STRAGGLING IN SILICON BY HIGH-ENERGY ELECTRONS, POSITIVE PIONS, AND PROTONS. Aitken, D. W.; Lakin, W. L.; Zulliger, H. R. (Stanford Univ., Calif.). Phys. Rev., 179: 393-8(Mar. 10, 1969).

The most probable energy loss and energy-loss straggling are investigated in lithium-drifted silicon for electrons, positive pions, and protons with energies 31.5 to 767.2 MeV. Very good agreement with theory is obtained with protons and pions. The electron spectra demonstrate effects that can be attributed to the absorption by the detector of a portion of the electron bremsstrahlung radiation. No apparent evidence for a predicted decrease in electron ionization through radiative corrections is observed. (auth)

27329 PRODUCTION EFFICIENCIES OF X-RAY EMISSION SPECTRA BY PROTON BOMBARDMENT. Sterk, A. A.; Marks, C. L.; Saylor, W. P. (American Machine and Foundry Co., Alexandria, Va.). Advan. X-Ray Anal., 10: 399-408(1967).

From 15th Annual Conference on Applications of X-Ray Analysis, Denver, Colo. See CONF-660814.

Production efficiencies for the excitation of characteristic soft x-ray-emission spectra by proton bombardment were investigated. Results were obtained for K-, L-, and M-shell lines of various elements as a function of proton energies ranging up to 100 keV. For comparison purposes, helium, nitrogen, and argon ions also were accelerated and used as bombarding particles to yield efficiency data for some of the same spectral lines. The data demonstrate that: (1) The production efficiencies of spectral lines excited by protons are, in the first approximation, dependent on wavelength only and are independent of the atomic shell with which they are associated. (2) Production efficiencies increase with the atomic weight of the bombarding ions for some of the spectral lines investigated. X-ray generation by proton bombardment is a powerful method for producing high-intensity monochromatic radiation for wavelengths above approximately 10Å. The same technique can be used for analytical purposes to determine the concentration of low-atomic-number elements. (auth)

27330 EXCITATION POTENTIALS AND SHELL CORRECTIONS FOR THE ELEMENTS $Z_2 = 20$ TO 30. Andersen, H. H.; Soerensen, H.; Vadja, P. (Atomic Energy Commission, Risoe, Denmark). Phys. Rev., 180: 373-80(Apr. 10, 1969).

Excitation potentials and shell corrections for the elements $Z_2 = 20$ to $Z_2 = 30$ are evaluated from experimental stopping-power data for 5 to 12-MeV protons and deuterons. Use is made of Walske's K- and L-shell corrections and shell corrections calculated by Bonderup on the basis of the Thomas–Fermi model. It is suggested that Cu be used rather than Al as a standard for stopping-power measurements. I_{Cu} is deduced to be 320.8 ± 3.8 eV. Relative stopping-power measurements by Bakker and Segrè, by Teasdale, by Bukig et al., and by Nakano et al., are normalized to Cu, and mean excitation potentials are found by means of Bonderup's shell corrections. With only a few exceptions, they agree with the I values obtained from the present measurements. Within the Z_2 interval treated here, it is found that I/Z_2 increases with increasing Z_2, contrary to the general trend through the periodic system of elements. (auth)

27331 SMALL-ANGLE SCATTERING OF ^{32}S AND ^{16}O BEAMS IN THIN FOILS. Cline, C. K.; Pierce, T. E.; Purser, K. H.; Blann, M. (Univ. of Rochester, N. Y.). Phys. Rev., 180: 450-5(Apr. 10, 1969).

The rms scattering angles introduced into beams of 10- to 70-MeV ^{16}O ions and 10- to 110-MeV ^{32}S ions by passage through thin foils of carbon, beryllium oxide, and aluminum oxide were measured. The foils used ranged in thickness from 5 to 50 $\mu g/cm^2$. Qualitative agreement with the predictions of multiple Coulomb scattering theory is found, but an overall normalization factor of 1.8 was needed in most cases to obtain quantitative agreement with the data. (auth)

27332 EMISSION PRODUCED BY EXCITED HELIUM MOLECULES WHEN SOLID TARGETS ARE BOMBARDED BY MEANS OF FAST HELIUM IONS. Gritsyna, V. V.; Kiyan, T. S.; Koval, A. G.; Fogel, Ya. M. (Kharkov State Univ.). JETP Lett. (USSR) (Engl. Transl.), 9: 124-7(Feb. 20, 1969).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 9: 212-15(Feb. 20, 1969).

The glow produced when solid targets (graphite, Ni, Pt, Pd) were bombarded by beams of 20-keV He^+ ions was studied. A glowing halo appears immediately after the start of the bombardment; after a certain time, which may be several hours, a new glow appears very close to the surface of the target. Studies of the spectra of the glows indicate that the initial halo is due to emission from excited helium atoms produced during scattering and neutralization of the primary ions when they interact with the target. The later surface glow is due to emission from excited He_2 molecules formed on the surface of the target. Possible mechanisms for the production of the excited He_2 molecules are considered briefly. (A.G.W.)

27333 FREE RADICAL BEAM SOURCE. Kalos, Ferenc; Grosser, Arthur E. (McGill Univ., Montreal). Rev. Sci. Instrum., 40: 804-6(June 1969).

A source of pure beams of thermal alkyl radicals for molecular beam scattering experiments is described. A parent compound, $(CH_3)_2Hg$, $(CH_3)_3Bi$, CH_3I, or $(C_2H_5)_2Hg$, was pyrolyzed in an array of small Ta tubes, and a beam of the products entered a slotted disk type velocity selector. Selection at 1500 m/sec chemically purified the radical beam by removing parent molecules and high mass decomposition products. The best purities, found by modulated beam mass spectrometry, average to 94 ± 8 mole % CH_3, and in these runs the estimated intensities were $2\text{-}7 \times 10^{15}$ radicals/sr · sec, or $3\text{-}10 \times 10^{13}$ radicals/cm^2 · sec at the detector. Light hydrocarbons (C_1,C_2) were the major impurities, their concentration increasing with methyl flux. (auth)

27334 ELASTIC SCATTERING OF 145-, 279-, 412-, AND 662-keV γ RAYS FROM LEAD. Schumacher, M. (Franklin Inst., Swarthmore, Pa.). Phys. Rev., 182: 7-14(June 5, 1969).

The differential cross section for elastic scattering of 145-, 279-, 412-, and 662-keV γ rays from lead has been measured in the angle interval 30 to 150° using a lithium-drifted germanium detector. The experimental results are in general agreement with the theory of Brown et al. Approximative formulas for the differential cross section of Rayleigh scattering are discussed. (auth)

27335 MEASUREMENT OF THE K-SHELL IONIZATION CROSS SECTIONS OF Al AND Mg FOR 1- TO 5-MeV α PARTICLES. Sellers, Bach; Hanser, Frederick A.; Wilson, Henry H. (Panametrics, Inc., Waltham, Mass.). Phys. Rev., 182: 90-6 (June 5, 1969).

The K-shell ionization cross sections of Al and Mg for 1- to 5-MeV α particles have been obtained from measurements of the fluorescent x-ray yields of thin foils irradiated by α particles. The results for Al range from $(0.36 \pm 0.31) \times 10^{-20}$ cm^2 at 1.0 MeV to $(13.47 \pm 0.77) \times 10^{-20}$ cm^2 at 5.0 MeV, and for Mg from $(1.04 \pm 0.25) \times 10^{-20}$ cm^2 at 1.0 MeV to $(16.61 \pm 0.56) \times 10^{-20}$ cm^2 at 5.0 MeV. The energy dependence is stronger than predicted by the Born approximation. The data are compared with theoretical calculations and with other experimental results for protons, ^3He, and α particles. (auth)

Atomic and Molecular Properties

Refer also to abstracts 27638 and 27732.

27336 STARK BROADENING OF Ar I AND Ar II LINES AT HIGH ELECTRON CONCENTRATIONS. Powell, William Richard. Baltimore, Johns Hopkins Univ., 1966. 103p.

Thesis.

Stark-broadened profiles for several Ar I and Ar II lines have been measured. These results have been compared with Griem's theoretical predictions. The shifts and widths observed for Ar I lines were less than predicted, but the difference did not exceed the combined theoretical and experimental uncertainties. However, the profiles observed were less symmetric than those predicted. For Ar II lines, the disagreement between the observed and predicted profiles was much larger than the combined uncertainties of experiment and theory. The fact that certain levels, particularly the $(^1D)3d^2F$ levels, were omitted from the calculations of Stark broadening for Ar II lines is suggested as a probable explanation of this disagreement. A highly reproducible transient plasma generator was developed for this study. The characteristics of this source were investigated to some extent and the homogeneity along the line of sight was investigated in detail. The temperature of the plasma was determined from measurements of the absolute intensities of spectral lines of Ar I and Ar II. For calculation of this temperature, a single noniterative equation was derived. The range of validity of this equation was explored. Electron concentrations were also derived from measurements of absolute intensities. However, the most accurate electron concentrations were based upon measurements of Stark-broadened hydrogen-line profiles H_α and H_β. Some comments with regard to current argon transition probabilities are made. (Diss. Abstr.)

27337 THEORETICAL INVESTIGATION OF THE LOWEST DOUBLE-MINIMUM STATE E, F $^1\Sigma_g^+$ OF THE HYDROGEN MOLECULE. Kolos, W.; Wolniewicz, L. (Univ. of Chicago). Contract DA-31-124-ARO-D-447. J. Chem. Phys., 50: 3228-40 (Apr. 15, 1969).

An accurate potential-energy curve for the first excited $^1\Sigma_g^+$ state of the hydrogen molecule has been calculated for $1 \leq R \leq 12$ a.u. The curve is known to have a double minimum, and for the outer minimum a significantly lower energy has been obtained than all previously reported results. The diagonal corrections for nuclear motion have also been computed and found to have a very sharp peak in the vicinity of the potential maximum. Vibrational and rotational levels have been calculated for all isotopes of the hydrogen molecule, and some results for H_2, D_2, and T_2 are shown and compared with experimental data. For the outer minimum, two, three, and four vibrational levels for H_2, D_2, and T_2, respectively, are reported, which lie below the lowest levels observed experimentally. For the observed levels good agreement with experimental data is obtained; however, the agreement is significantly worse when only the clamped nuclei potential without the diagonal corrections is used in the calculation of the vibrational energies. The wave function is analyzed in terms of some simple functions and appears to drastically change its character in the vicinity of the potential maximum. (auth)

27338 GEOMETRIC-MEAN VARIATION FUNCTION FOR H_2^+. Radel, Stanley R.; Gorman, Ronnie; Cutler, Carol; Kahn, Luis (City Coll., New York). J. Chem. Phys., 50: 3642-4 (Apr. 15, 1969).

Energy results calculated from a new two-parameter variation function for the $1s\sigma$ ground state of H_2^+ are given for various internuclear separations. The function builds up the probability density at intermediate distances by the addition of a geometric-mean term to the well-known Finkelstein–Horowitz function; it satisfies the minimum criteria for a valid ground-state H_2^+ wave function. The Rayleigh–Ritz variation method was used to find the energy as a function of effective charge and internuclear distance. The calculated energies agree with exact energies [Wind, J. Chem. Phys., 42: 2371(1965)] to within 0.0003 a.u. for the full range of internuclear separations. (A.G.W.)

27339 LOWER BOUNDS TO ENERGY EIGENVALUES. Mazziotti, Alexander (Johns Hopkins Univ., Baltimore). J. Chem. Phys., 50: 3339-42(Apr. 15, 1969).

Recently, Schwartz has considered the application of the lower-bound formulas of Temple, Weinstein, and Stevenson to molecular systems whose wave functions are built up from a Gaussian basis set. To test the convergence of the lower-bound formulas, he applied them to the ground state of the hydrogen atom. The results, using variationally optimized upper-bound Gaussian wave functions, were poor. It is demonstrated here that the convergence rate of these lower bounds can be accelerated by optimization of both linear and nonlinear parameters in the wave function with respect to the maximization of the lower bound. These improved results are then analyzed from the spectral-impurity and local-energy viewpoints, and it is shown that the lower-bound wave functions obtained are particularly suited for reproducing the slope of the wave function at regions very close and very far away from the nucleus. Finally, the previous lower-bound calculations of Wilets and Cherry are considered in the light of these results. (auth)

27340 SURFACE AND VACUUM PHYSICS INDEX. Volume 3, No. 11(1597-1753), 1968. Hilsenbeck, D. (ed.). AED Bibliographien zur Kernforschung und Kerntechnik. Frankfurt am Main, Zentralstelle fuer Atomkernenergie-Dokumentation, 1968. 102p. DM 70,-.

One hundred and fifty-six papers on various aspects of surface and vacuum physics are listed. Subject and author indexes are included. (M.O.W.)

27341 RELATIVISTIC RADIATION FROM SINGLE-ELECTRON TRANSITIONS. Kalade, Yu. A. (Vilnyus State Univ., USSR). Liet. Fiz. Rinkinys, Liet. TSR Mokslu Akad., Liet. TSR Aukst. Mokyklos, 8: No. 1–2, 69–75(1968). (In Russian).

The matrix elements of the relativistic single-electron transitions are given in a first approximation of perturbation theory. Approximate formulas are then derived, which are valid for the x-ray spectrum and for mesoatoms. (tr-auth)

27342 USE OF ASYMPTOTICALLY CORRECT WAVE FUNCTION FOR THREE-BODY RAYLEIGH–RITZ CALCULATIONS. Rotenberg, Manuel; Stein, Josef (Univ. of California, San Diego, La Jolla). Phys. Rev., 182: 1-7(June 5, 1969).

A quickly converging expansion for three-body variational wave functions is obtained by adding to the usual Hylleraas wave functions terms that express the correct asymptotic behavior. This modified expansion is applied to three problems: the H^- ground state; a search for a $He-e^+$ bound state; a search for a $H-e^+$ scattering resonance below the positronium threshold. The H^- calculation shows a marked improvement in convergence over using Hylleraas functions alone. It is also found that there is no $H-e^+$ bound state unless the mass of the positron is greater than 2.20 electron masses. Similarly, no positron scattering resonance below positronium threshold exists unless the mass of the positron is less than about 0.7 electron masses. (auth)

27343 P AUTO-IONIZATION STATES OF He AND H$^-$. Bhatia, A. K.; Temkin, A. (Goddard Space Flight Center, Greenbelt, Md.). Phys. Rev., 182: 15-24(June 5, 1969).

Precision calculations of the energies of P auto-ionization states of He and H$^-$ are continued, and calculations of widths and shifts are initiated. The P-wave Hylleraas-type wave function of a previous calculation (Bhatia, Temkin, and Perkins) is augmented to include 56 terms, among them the most important powers of r_1, r_2, and r_{12} omitted in the previous calculation. The associated wave functions are then used to calculate shifts, widths, and q values with exchange, exchange adiabatic, and polarized orbital wave functions representing the nonresonant continuum. It is found that the latter gives the most satisfactory agreement with experiment. Corrections for nearby resonances are also included. The variational calculation has been extended to include 84 terms for the ^{1}P states of He. With inclusion of the shift, the positions of the first two resonances are within the experimental values of Madden and Codling; however, the lowest state is about 0.01 eV removed from the central value of the experiment. The mass-polarization correction is also discussed, but its value is far too small to reconcile the deviation from the mean. (auth)

Positronium, Muonium, and Mesic Atoms and Molecules

Refer also to abstracts 27341 and 27542.

27344 (AD-680818) RESEARCHES ON POSITRONIUM. Final Report. Green, James H. (New South Wales Univ., Kensington (Australia). Dept. of Nuclear and Radiation Chemistry). Nov. 1965. 6p. (AFOSR-69-0043-TR). CFSTI.

The results of research on the study of aqueous and liquid systems are given. Particular attention is directed to the formation of positronium compounds and to the behavior of positronium in a system undergoing ionizing radiation. Equilibrium conditions for positronium-compound formation in simple systems were also studied. (auth) (USGRDR)

27345 THE QUANTUM HARD-SPHERE GAS AT HIGH DENSITIES AND NUCLEAR POLARIZATION CORRECTIONS TO THE LEVELS OF MUONIC ATOMS. Cole, Randall Knight Jr. Stanford, Calif., Stanford Univ., 1968. 116p.

Thesis.

In the first part the properties of a quantum hard-sphere gas in the limit of high densities are investigated, with particular emphasis on the ground-state energy per particle. This has the asymptotic form $E_0/N_{\rho}\simeq_{\rho_0}(\hbar^2/2m)\,A(\rho^{-1/3}-\rho_0^{-1/3})^{-2}$ as deduced from the Heisenberg principle, and is independent of particle statistics. A model of hard spheres arranged in a simple cubic lattice is solved by reduction to the known one-dimensional case, and gives $A_{s.c.} = \pi^2$. For more realistic close-packed systems it is estimated that $A_{c.p.} \approx 10$ to 15, for which this form connects smoothly to the well-known low-density gas-parameter expansions. Phonon properties in the Debye approximation are derived. The model is applied to the zero-point kinetic energies of hcp ^{3}He, ^{4}He, H$_2$, and D$_2$, as determined from pressure data. The helium data give A ≈ 15.7, the hydrogen data A ≈ 15.9. The fitted hard-core diameters, 1.73 Å and 1.90 Å, respectively, are smaller than expected from accepted potentials; this is discussed. Thermodynamics of the simple cubic system give $c_v \propto T$ for both bosons and fermions, which may explain the anomalous (non-Debye) contributions to the heat capacities of solid ^{3}He and ^{4}He at low temperatures. In part two it is shown that information about the nuclear electromagnetic transition vertex derived from experimental inelastic electron-scattering cross sections may be used to evaluate the nuclear polarization (dispersion) corrections to the levels of muonic atoms. A model-independent result is obtained for the contributions of discrete nuclear states. The most important systematic features of nuclear excitation spectra, the giant dipole resonance and the quasielastic peak, are considered in detail. The Goldhaber–Teller model is used for the former, and a simple harmonic oscillator shell model for the latter. Numerical estimates are obtained for total level shifts of low-lying muon states in nuclei with closed (harmonic oscillator) proton shells, using closure approximation for the muon. The muon closure energies are considered in detail. It is felt that the results obtained are probably accurate to a factor of two. The shifts are estimated to be several keV for the 1s state in heavy nuclei, and somewhat less (a few tenths to about one keV) for the 2s and 2p states. These shifts are significant in comparison to the present accuracy of measurement of muonic x-ray spectra, and should be considered in calculations to fit nuclear charge distributions. (Disser. Abstr.)

27346 FORMATION AND QUENCHING OF ORTHOPOSITRONIUM IN MOLECULAR MATERIALS. Lagu, R. G.; Kulkarni, V. G.; Thosar, B. V.; Chandra, G. (Tata Inst. of Fundamental Research, Bombay). Proc. Indian Acad. Sci., Sect. A, 69: 48-65(Jan. 1969).

A correlation is observed between the lifetime and two-photon annihilation intensity by the pick-off process of ortho-positronium in molecular materials. An empirical model, in terms of free volume, is developed to explain this correlation. The variation in lifetime and intensity with change of temperature and pressure, with melting of crystals, and with glass transition in polymers is considered on the basis of this model. (auth)

27347 ABOUT THE POLARIZATION IN THE THREE-PARTICLE SYSTEM (μ-MESIC ATOM). Tammet, E. (Inst. of Cybernetics, Tallin). Izv. Akad. Nauk Est. SSR, Fiz., Mat., 18: No. 1, 120-2(1969). (In Russian).

Previously it was shown that the polarization of a μ-meson in a spin-$\frac{1}{2}$ mesoatom comprised about 50% of the initial polarization fixed at the moment of μ-meson entrance into the K-shell. Magnetic interactions of the μ-meson and the nucleus with the electron shell were not taken into consideration in the previous studies. An attempt was made to evaluate the effect of such interactions in considering a system of three initially free particles. Spin-$\frac{1}{2}$ particles and initial polarization of only one particle were assumed in resolution of the problem. (R.V.J.)

27348 POSITRONIUM FORMATION IN POSITRON–HELIUM SCATTERING. Fels, Margaret Fulton (Univ. of California, Los Angeles); Mittleman, Marvin H. Phys. Rev., 182: 77-84(June 5, 1969).

An approximation method developed by Chen and Mittleman has been used to investigate the process of positronium formation in positron–helium scattering. The energy range in which only ground-state positronium may be formed is considered. This method leads to an approximation made on a projection-operator technique, and further includes a coordinate change that allows the expression of the entire problem in terms of the positron coordinate. The result is two coupled ordinary differential equations, of second order, which may be solved numerically. The projection-operator technique leads naturally to the inclusion of the polarizability of both helium and positronium in the potentials that appear in the final equations, and a thorough investigation is made of the effects of various forms for the polarization potentials. The results await a comparison with experimental data, which are expected to be made available in the near future. (auth)

27349 DOUBLE-ELECTRON CAPTURE BY POSITRONS PASSING THROUGH HELIUM. Ferrante, G.; Geracitano, R. (Univ., Messina, Italy. Gruppo Nazionale di Struttura della Materia, Messina, Italy). Phys. Rev., 182: 215-22(June 5, 1969).

The total cross section for double-electron capture by positrons passing through helium atoms is calculated by the Born approximation for positron energies up to 250 eV. It is found that the maximum value of the cross section, 0.0058 πa_0^2, occurs at the positron energy of 100 eV. This value is about 2 orders of magnitude smaller than the existing values of the cross section for single-electron capture by positrons in helium. In order to calculate the matrix element of the problem, the Feynman's parametrization method is used. The method is used for two parallel cases: (A) in its usual, straightforward form, which requires the introduction of three parameters, and (B) in a slightly modified form, to the authors' knowledge never used before, allowing the reduction of the number of the parameters to two. This double calculation is mainly intended to give, together with a more accurate result for the cross section, the possibility of investigating the convergence of the results obtained in a three-parameter calculation to the two-parameter results. (auth)

Collision Phenomena

Refer also to abstracts 27342, 27466, and 27691.

27350 (AD-673963) ELECTRON SPIN POLARIZATION BY LOW-ENERGY SCATTERING. Kessler, J. (Stanford Univ., Calif. High-Energy Physics Lab. Technische Hochschule, Karlsruhe (West Germany). Physikalisches Institut). Apr. 1968. Contract Nonr-225(67). 81p. (HEPL-532). CFSTI.

The status of theory and experiment of electron polarization by scattering at energies between a few eV and a few keV is reviewed. Polarization effects in scattering from free atoms, molecules, and solid targets are discussed. Apart from a survey of the problems solved, a perspective is given of the work that would be interesting to pursue in this rapidly developing field of research. (auth) (USGRDR)

27351 (AD-681158) EXPERIMENTAL DETERMINATION OF THE CROSS SECTIONS FOR NEUTRAL BREMSSTRAHLUNG. I. Ne, Ar, AND Xe. Taylor, Raymond L.; Caledonia, George

(Avco-Everett Research Lab., Everett, Mass.). Nov. 1968. Contract F04701-68-C-0036. 54p. (AERL-RR-311; SAMSO-TR-68-386). CFSTI.

Experimental measurements of the cross sections for radiative scattering of electrons from the neutral species Ne, Ar, and Xe have been obtained. The experiments were performed in shock-heated gases from 8000 to 15,000°K using a rapid-scanning spectrometer to measure the absolute intensity of the neutral bremsstrahlung continuum over the wavelength interval of 2.0 to 5.4 microns in the infrared. The data have been analyzed to obtain the effective nuclear charge squared of the species i doing the scattering using a modified form of the Kramers–Unsold equation, and to obtain the radiative absorption cross section Qa_i. Experimental information on the temperature and wavelength dependence of the neutral bremsstrahlung has been determined. The experimental Qa's have been compared with calculations based on a simple theory of radiative scattering of electrons from neutral species. (auth) (USGRDR)

27352 (AD-681159) EXPERIMENTAL DETERMINATION OF THE CROSS SECTIONS FOR NEUTRAL BREMSSTRAHLUNG. II. HIGH-TEMPERATURE AIR SPECIES: O, N, AND N_2. Taylor, Raymond L.; Caledonia, George (Avco-Everett Research Lab., Everett, Mass.). Nov. 1968. Contract F04701-68-C-0036. 39p. (AERL-RR-312; SAMSO-TR-68-375). CFSTI.

The low-energy cross sections for neutral bremsstrahlung for the major species of high-temperature air (O, N, and N_2) have been measured. The experiments were performed behind reflected shocks by measuring the absolute, infrared intensity of appropriate shock-heated gas mixtures. The radiation was detected with a rapid-scanning infrared spectrometer covering a total spectral range of 2.0 to 5.4 microns. The data were analyzed by assuming that the observed continuum was due to free–free scattering of electrons from the neutral species in the gas studied. The neutral bremsstrahlung cross section was determined for (1) atomic oxygen in O_2–Ne mixtures, (2) atomic nitrogen in N_2–Ne mixtures, and (3) for molecular nitrogen from data on pure N_2. Further checks on the experimental values were obtained by comparing the measured cross sections with intensity data from air and N_2–Ar and N_2–Ne mixtures. The data were analyzed for the effective nuclear charge squared and radiation absorption cross section of the active species. The data are compared with previous experimental measurements and with theoretical calculations. (auth) (USGRDR)

27353 (CALT-532-39(Vol.1)) LOW-ENERGY, HIGH-RESOLUTION, VARIABLE ANGLE ELECTRON IMPACT SPECTROSCOPY. Rice, James Kinsey (California Inst. of Tech., Pasadena). 1969. 246p. Dep. CFSTI.

Thesis.

The design, construction, operation, and performance of a low-energy, variable-angle, high-resolution, electron-impact spectrometer are described. A brief historical review of the experimental development of electron scattering is presented. Relevant aspects of scattering theory are reviewed. The Ochkur–Rudge approximation is applied to calculation of the exchange excitation of ethylene ($X^1A_g \rightarrow a^3B_{1u}$) by electron impact. Results of measurements made with the spectrometer are presented in CALT-532-39 (Vol. 2). (A.G.W.)

27354 (CALT-532-39(Vol.2)) LOW-ENERGY, HIGH-RESOLUTION, VARIABLE ANGLE ELECTRON IMPACT SPECTROSCOPY. Rice, James Kinsey (California Inst. of Tech., Pasadena). 1969. 490p. Dep. CFSTI.

Thesis.

A low-energy, variable-angle, high-resolution, electron-impact spectrometer described in CALT-532-39(Vol. 1) was used to measure the differential scattering cross sections for the electron-impact excitation of helium and five molecules (N_2, CO, H_2, C_2H_2, and C_2H_4) as a function of incident-electron kinetic energy (from about 20 to 60 eV) and scattering angle (from about −30° to +80°) with a resolution of 0.04 to 0.15 eV. These studies included the observation of twenty-nine electronically excited states, including 12 singlet → triplet transitions. Comparisons of these results with presently available theoretical predictions indicate the inadequacy of the latter. The vibrational structure within several electronic bands was resolved, and the relative vibrational intensities were compared with optical and calculated relative Franck–Condon factors. Discrepancies, due to underlying forbidden transitions, were noted in H_2, acetylene, and ethylene. Some general "spectroscopic rules" for the identification of spin-forbidden excitations observed by electron-impact are presented. These rules were derived from an examination of the angular dependencies of the differential cross sections for twenty-six known transitions. On this basis, one state in N_2 ($E^3\Sigma_g^+$) was identified as a triplet, and two previously unknown low-lying triplet states in C_2H_2 at 5.2 eV and 6.1 eV were detected and characterized. (auth)

27355 (N-69-10454) POSITIVE ION REACTIONS. Fite, Wade L. (Pittsburgh Univ., Pa. Space Research Coordination Center). May 17, 1968. 37p. (NASA-CR-97601; SRRC-74). CFSTI.

An overview is presented of the principal laboratory methods used to obtain thermal-energy data on total cross sections and reaction rate coefficients for ion–neutral reactions. Modifications of these methods and alternative methods are summarized that can be used to assess the effects of increased kinetic energy and reactants in excited states; contributions of higher-energy experiments are discussed. Only reactions involving positive ions are considered in this review, which covers energy processes of interest to aeronomy. Details are included for mass-spectrometric and ion-cyclotron-resonance methods used at energies of 0.008 to 0.05 eV; secondary ions and pulsed sources in mass spectrometers, drift tubes, and merging beams used in energies between 0.025 and 10 eV; and double mass-spectrometric and crossed-beam methods for medium- to high-energy studies. (STAR)

27356 (N-69-15742) CROSS SECTIONS FOR IONIZATION IN COLLISIONS BETWEEN EXCITED NITROGEN MOLECULES AND ARGON ATOMS, OXYGEN MOLECULES, AND NITRIC OXIDE MOLECULES. Utterback, Nyle G.; Van Zyl, Bert (General Motors Corp., Santa Barbara, Calif. AC Electronics–Defense Research Labs.). Dec. 1968. Contract NAS2-4924. 26p. (NASA-CR-73287; TR-68-65). CFSTI.

A molecular beam of N_2 in the $A^3\Sigma_u^+$ state has been used to bombard target molecules of Ar, O_2, and NO. The ionization cross sections have been determined for these collisions at kinetic energies from a few eV above the energy threshold to 100 eV above threshold in the center-of-mass coordinate system. Preliminary measurements of the cross section involving CO target molecules have also been made. A comparison of all these cross-section values with those obtained using ground-state N_2 molecules indicates that internal electronic energy is roughly equivalent to an equal amount of kinetic energy in producing ionization by a given ionizing process. However, certain selection rules appear to limit the ionizing processes that can occur, thereby decreasing the total cross section in some cases at a given kinetic-plus-internal energy. (auth) (STAR)

27357 (N-69-18056) IONIZATION OF EXCITED ATOMIC HYDROGEN BY FAST ELECTRONS. Omidvar, Kazem (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Dec. 1968. 63p. (NASA-TM-X-63434; X-641-68-505). CFSTI.

Electron-impact ionization cross section, energy distribution, and the average energy of the ejected electrons for the first five principal quantum numbers of atomic hydrogen, and all the azimuthal quantum numbers, are calculated within the Born approximation. Calculations are extended to a range of 100 to 900 threshold units of energy. Regions of agreement and disagreement between the high-energy quantal and classical calculations are analyzed. Validity of the Born approximation for excitation and ionization for a single-particle model is given. An energy spectrum of the secondary electrons from the passage of an energetic electron in a hydrogen-atom gas is found. (auth) (STAR)

27358 FINE-STRUCTURE TRANSITIONS AND SHAPE RESONANCES. Reid, R. H. G.; Dalgarno, A. (Harvard Coll. Observatory, Cambridge, Mass. Smithsonian Astrophysical Observatory, Cambridge, Mass.). Phys. Rev. Lett., 22: 1029-30(May 19, 1969).

A partial-wave description is employed to calculate the cross sections for fine-structure transitions in the ^2P state of sodium in collisions with helium. The cross sections show an oscillatory behavior with energy that is related to the occurrence of shape resonances in the elastic-scattering channels. (auth)

27359 INELASTIC ENERGY LOSS AND X-RAY EMISSION IN LARGE-ANGLE ATOMIC COLLISIONS. Kessel, Q. C. (Robert J. Van de Graaff Lab., Burlington, Mass.); Rose, P. H.; Grodzins, L. Phys. Rev. Lett., 22: 1031-4(May 19, 1969).

Usually large inelastic energy losses have been measured for single collisions of argon ions with argon atoms and of iodine ions with xenon atoms using ion energies from 0.5 to 6 MeV and scattering angles from 4 to 20 deg. These losses, as high as 28 keV, are attributed in part to the production of inner-shell vacancies. The measurement of the energies of x rays from these collisions support this hypothesis. (auth)

27360 ELECTRON-IMPACT EXCITATION OF CARBON MONOXIDE NEAR THRESHOLD IN THE 1.5- TO 3-eV INCIDENT ENERGY RANGE. Rempt, R. D. (Univ. of California, Los Angeles). Phys. Rev. Lett., 22: 1034-6(May 19, 1969).

A low-energy excitation process in CO at approximately 2.3 eV is investigated near threshold by a trapped-electron method.

Structure has been observed in this excitation for the first time. An upper limit to the electron affinity of CO is established at −1.8 ± 0.1 eV. (auth)

27361 EXPANSION TECHNIQUE FOR INELASTIC SCATTERING. Harris, Frank E. (Univ. of Utah, Salt Lake City); Michels, H. H. Phys. Rev. Lett., 22: 1036-9(May 19, 1969).

A nonarbitrary method is presented for the calculation of inelastic-scattering wave functions by an expansion technique. The method can be applied for any incident energy, including values at resonances resulting from stable or metastable bound states. Calculations for an exactly soluble two-channel model problem illustrate the utility of the method. (auth)

27362 ENERGY STRAGGLING OF ALPHA PARTICLES THROUGH GASES. Ramirez, J. J.; Prior, R. M.; Swint, J. B.; Quinton, A. R.; Blue, R. A. (Univ. of Florida, Gainesville). Phys. Rev., 179: 310-14(Mar. 10, 1969).

Measurements of the energy straggling of α particles through helium, air, argon, krypton, and xenon have been made for incident α energies between 2 and 4 MeV. These measurements were compared with the theoretical results of Bohr, Lewis, and Titeica. None of these theories gives satisfactory fits to the data, giving at best predictions within an order of magnitude of the experimental results. Capture and loss of electrons is a significant effect at these energies. The neglect of this effect and of the exact energy shell corrections, rather than an average shell correction, is believed to be the reason for the failure of these theories. Values of the stopping power for the α particles were also obtained. These were found to be in good agreement with proton energy-loss measurements after the usual corrections for mass and charge differences were made. (auth)

27363 RETARDATION IN THE ELASTIC SCATTERING OF PHOTONS BY ATOMIC HYDROGEN. Gavrila, M.; Costescu, A. (Bucharest Univ.). Phys. Lett., 28A: 614-15(Feb. 10, 1969).

The nonrelativistic matrix element for elastic scattering of photons by atomic hydrogen in the ground state is evaluated analytically in a closed form that takes retardation into account. The result is expressed in terms of essentially two Appell hypergeometric functions F_1. (auth)

27364 ENERGY DEPENDENCE OF THE CHARGE-TRANSFER REACTION $N_2^+ + O_2 \rightarrow N_2 + O_2^+$ IN THE THERMAL AND LOW ELECTRON VOLT REGION. Wolf, F. A.; Turner, B. R. (Gulf General Atomic Inc., San Diego, Calif.). J. Chem. Phys., 50: 3645-6(Apr. 15, 1969).

A formula for the charge-exchange cross section for the reaction $N_2^+ + O_2 \rightarrow N_2 + O_2^+$ is proposed, which is based on division of the collision probability into two parts involving the formation and nonformation of a capture complex. When the square root of the reaction cross section is plotted as a function of energy, the theory predicts a minimum if f, the fraction of collision complexes breaking up into the charge-transfer channel, is less than ½ and is independent of the interaction energy and if the higher-energy behavior of the cross section is assumed to be as described by the Rapp–Francis theory. Such a plot is shown for f = 0.10; a minimum is seen at E = 2.25 eV. (A.G.W.)

27365 ASYMPTOTIC EVALUATION OF WKB MATRIX ELEMENTS. Pack, Russell T.; Dahler, John S. (Univ. of Minnesota, Minneapolis). J. Chem. Phys., 50: 2397-2403 (Mar. 15, 1969).

A procedure is given for the analytic asymptotic evaluation of certain integrals that arise in the quantum-mechanical theory of inelastic molecular collisions. The integrals are evaluated using WKB wave functions and the saddle-point method. The method is equivalent to Landau's but is considerably more transparent and is easily applied to vibrational and rotational transitions for which there is no crossing of potential-energy surfaces, as well as to electronic transitions near a crossing point. The special case of resonance collisions is discussed, and the method is illustrated with an example. (auth)

27366 GLORY SCATTERING OF LITHIUM BY A SERIES OF MOLECULES. II. FLUOROCARBONS AND HYDROCARBONS. Rothe, Erhard W.; Helbing, Reinhard K. B. (General Dynamics/Convair, San Diego, Calif.). Contract AF49(638)-1730. J. Chem. Phys., 50: 3531-8(Apr. 15, 1969).

The velocity dependence of the total cross section has been measured for the scattering of lithium-7 by 26 fluorocarbon and hydrocarbon molecules, and by CH_3F, CH_2F_2, and CHF_3, in the velocity range from about 1 to 4 km/sec. This work is similar to that described in a previous paper in which the scattering was from 13 diatomics. Potential parameters were derived for these systems. The quenching of the normal glory pattern may be qualitatively correlated with the geometric structures of the scatterers. Glory scattering persists even for rather complex molecules (e.g., CF_3–cyclo–C_6F_{11}). The saturated fluorocarbons may be roughly thought of as rare gases of varying shape. The data are in reasonable agreement with previous work, although the present interpretation differs. (auth)

27367 REDUCTION OF THE EFFECT OF THE SPEED DISTRIBUTION IN THE CROSS BEAM ON NONREACTIVE SCATTERING EXPERIMENTS. Greene, E. F. (Brown Univ., Providence); Lau, M. H.; Ross, John. J. Chem. Phys., 50: 3122-3(Apr. 1, 1969).

It is shown that for an experimental arrangement involving selection of the primary-beam velocity v_1 by use of a thermal distribution for the velocity v_2 of the cross beam, the effect of the distribution of speeds v_2 may be substantially reduced for nonreactive scattering by having the detector scan the angular range in a plane containing v_1 and normal to v_2. (A.G.W.)

27368 EFFECT OF SPIN-ORBIT COUPLING UPON ELASTIC COLLISIONS BETWEEN ALKALI ATOMS. Klar, H. (Univ., Freiburg i. B.). Z. Phys., 223: 61-70(1969).

Within the framework of helicity formalism, the scattering between alkali metal atoms at thermal energies is discussed; the spin–orbit interaction is taken into account. Polarized cross sections show some small spin effect, unpolarized cross sections remain almost unchanged. (auth)

27369 ASYMPTOTIC BEHAVIOR OF THE WAVE FUNCTION OF IONIZATION PROCESSES AT ZERO ENERGY. Liepin'sh, A. K.; Peterkop, R. K. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 1, 17-25(1969). (In Russian).

The asymptotic form of the wave function is reviewed in a quasi-classical approximation describing the hydrogen-atom ionization by electrons at zero energy. The solution of quasi-classical equations is used to demonstrate the presence of a singularity in the asymptotic form proposed by Rudge and Seaton. By means of the condition of singularity absence another value is obtained for the exponent that determines the dependence of the wave function on the radius in the configuration space. The results are in agreement with the classical theory of Wannier. (auth)

27370 ELECTRON-IMPACT EXCITATION OF THE HYDROGEN MOLECULE. Fajen, Fredric E. Norman, Okla., Univ. of Oklahoma, 1968. 154p.

Thesis.

The cross sections for the excitation by electron impact of the singlet states of the n = 2 manifold (E $2s\sigma\ {}^1\Sigma_g^+$, B $2p\sigma\ {}^1\Sigma_u^+$, and C $2p\pi\ {}^1\Pi_u$) of the hydrogen molecule are calculated. The electronic wave functions used are those calculated by E. R. Davidson by the variational method. Vibrational wave functions are found by a numerical integration of the wave equation, using the best theoretical potential curves currently available. The excitation cross sections are calculated by the first Born approximation (BI), the two-state close-coupling method (2s), and the "full" close-coupling approximation (CC), in which the coupling between different excited electronic states is included. For electron energies of 25 eV and higher, it is found that the coupling between all pairs of electronic states is in the weak coupling regime, and that the coupling between the different excited states affects the computed cross sections by ten percent or less. The BI cross sections are within 10% of the CC results for electron energies of 50 eV and higher. The BI approximation underestimates the cross section at very low energies, owing to its neglect of distortion. The effects of coupling between the different vibrational levels are investigated and found to be unimportant for electron energies more than a few eV above threshold. The Franck–Condon factors are found to give the relative cross sections for excitation of the vibrational levels fairly accurately for the C and E states, but are in error by as much as 50% in the case of the B state. This error is due to the neglect of the variation of the electronic wave function of the excited state with internuclear separation. (Diss. Abstr.)

27371 FORMATION OF He^- IONS IN CHARGE-CHANGING COLLISIONS DURING PASSAGE OF FAST HELIUM BEAMS THROUGH HYDROGEN. Gilbody, H. B.; Browning, R.; Dunn, K. F.; McIntosh, A. I. (Queen's Univ., Belfast). J. Phys., B (London), 2: 465-70(Apr. 1969).

The role of fast metastable helium atoms in the formation of He^- ions by charge-changing collisions during the passage of 100-keV helium beams through hydrogen was investigated quantitatively. It is shown that He^- ions are formed by collisions involving one-electron capture by fast metastable helium atoms while all other possible production mechanisms are found to be relatively insignificant. A lower bound of $5.4 \pm 0.4 \times 10^{-18}$ cm^2 is obtained for the cross section for He^- formation from $He(2\ {}^3S)$ atoms. (auth) (UK)

27372 QUANTUM TRANSITION PROBABILITIES FOR ATOM–TRIATOMIC-MOLECULE COLLISIONS. Grimaldi, John J.; Endres, Paul F.; Wilson, David J. (Univ. of Rochester, N. Y.). J. Chem. Phys., 50: 1627-30(Feb. 15, 1969).

The method of Shuler and Zwanzig is extended to permit the calculation of collisional transition probabilities for triatomic molecules having harmonic intramolecular potentials and interacting impulsively with the bombarding atoms. Only colinear systems are considered. The results are qualitatively similar to those obtained for atom–diatom systems. Excitation of the symmetric mode of oscillation is favored over the antisymmetric mode in the systems considered. (auth)

27373 ROLE OF POTENTIAL CURVE CROSSING IN SUB-EXCITATION MOLECULAR COLLISIONS: EXACT (TWO-STATE) COMPUTATIONS VS DECOUPLING APPROXIMATIONS FOR RESONANCE POSITIONS. Levine, R. D. (Hebrew Univ., Jerusalem); Johnson, B. R.; Bernstein, R. B. J. Chem. Phys., 50: 1694-1701(Feb. 15, 1969).

Exact numerical solutions for two-state curve-crossing problems in the subexcitation region are presented and discussed in terms of various decoupling schemes. These provide an approximate, single-channel description of the problem. The energies of the bound states in the (decoupled) closed channel are used as approximations for the resonance positions. The transition from a weak to a strong coupling regime is discussed and a treatment of the resonances in the intermediate coupling region using a diabatic basis is provided. (auth)

27374 PSEUDOPOTENTIAL METHOD FOR INELASTIC PROCESSES IN ATOMS AND MOLECULES. I. GENERAL METHOD AND PHOTODETACHMENT OF O^-. Schneider, Barry; Weinberg, Michael; Tully, John; Berry, R. Stephen (Univ. of Chicago). Phys. Rev., 182: 133-41(June 5, 1969).

With the ultimate goal of elucidating inelastic processes in molecules, a pseudopotential method was developed by which the wave functions for electron scattering states around atoms, molecules, and their respective ions can be constituted. The method depends upon knowledge of the phase shift, obtained from scattering experiments or from quantum-defect calculations. A one-parameter model is chosen to fit the boundary conditions, and an approximate pseudowave function is derived from it. First-order perturbation theory is then carried out in the Green's function formalism, both to yield an improved wave function and to fit the parameter that optimizes the model. As a test of the model, the theory is applied to the calculation of the s-wave continuum wave function and cross section for the photodetachment of electrons from O^-. (auth)

27375 MEASUREMENT OF THE TOTAL CROSS SECTION FOR CHARGE TRANSFER INTO THE METASTABLE STATE H(2s) FOR PROTONS INCIDENT ON H_2 AND Ar GASES. Bayfield, James E. (Yale Univ., New Haven). Phys. Rev., 182: 115-28 (June 5, 1969).

The energy dependence of the total cross section for $H^+ + H_2 \rightarrow H(2s) + H_2^+$ exhibits two broad maxima in the range 2 to 70 keV. The lower maximum occurs at an energy where the total charge-transfer cross section is largest, and thus may be due to coupling with the ground-state scattering channel. The observed energy dependence is similar to that for $H^+ + H_2 \rightarrow Ly\ \alpha$, but with the positions of both maxima shifted to higher energies by about 5 keV. The cross section for $H^+ + Ar \rightarrow H(2s) + Ar^+$ over the extended energy range 2 to 70 keV also exhibits only two maxima. Internal and external quenching measurements of this cross section are in agreement. Its absolute magnitude at 20 keV has now been independently measured by three investigators, with results consistent within ±20%. (auth)

27376 ELECTRON-ALKALI-METAL INELASTIC RECOIL EXPERIMENTS WITH SPIN ANALYSIS: EXPERIMENTAL METHOD AND THE SMALL-ANGLE BEHAVIOR OF THE $4^2S_{1/2} \rightarrow 4^2P_{1/2,3/2}$ EXTRACTION OF POTASSIUM. Rubin, K.; Bederson, B.; Goldstein, M.; Collins, R. E. (New York Univ.). Phys. Rev., 182: 201-4(June 5, 1969).

The use of the atomic-beam recoil technique in the study of differential inelastic electron–atom collisions with spin analysis is discussed. The general theory of the experimental method is presented. The relation of the observable R, the fractional depolarization of a polarized atom beam, to the several direct and exchange scattering amplitudes is shown. A linear momentum-transfer analysis, required to connect the atomic and electron scattering angles, is also given. Some observations of the change of spin state of potassium, resulting from small-angle excitations of $4^2S_{1/2} \rightarrow 4^2P_{1/2,3/2}$ transitions are discussed and are related to the threshold laws. (auth)

27377 ELECTRON SCATTERING BY THE METASTABLE RARE GASES. Robinson, E. J. (New York Univ., Bronx). Phys. Rev., 182: 196-200(June 5, 1969).

Calculations are presented for elastic scattering of electrons by the $^3S_1$ metastable state of helium, and the $^3P_2$ metastable states of neon, argon, krypton, and xenon; an effective potential that matches the experimental binding energy of negative ions and incorporates the known atomic polarizability as a parameter is used. The results are in fair agreement with experiment and one other calculation for the case of helium. All the results are characterized by large cross sections and by the large contributions of higher angular momenta at low energies. (auth)

27378 ROTATIONAL EXCITATION IN ION–MOLECULE COLLISIONS. II. H^+, D^+, He^+, Ne^+, H_2^+, and D_2 ON Ne. Moore, John H. Jr.; Doering, John P. (Johns Hopkins Univ., Baltimore). Phys. Rev., 182: 176-80(June 5, 1969).

A study was made of the rotational line intensities in the (0,0) band of the N_2^+ first negative system produced by ion bombardment of N_2 at 130°K. H^+, D^+, He^+, Ne^+, H_2^+, and D_2^+ projectile ions at energies of 600 eV to 10 keV were used. The distribution of rotational energy in the upper state of the first negative system was found to deviate from a Boltzmann distribution for projectile ion velocities below 10^8 cm/sec. Excitation to high rotational states increased monotonically with decreasing projectile velocity. The band envelope of spectra excited by atomic ions displayed a characteristic shape different from that excited by the molecular ions. For atomic ion excitation the extent of excitation to high rotational excitation to high states with respect to other types of experiments are discussed. (auth)

27379 DIFFERENTIAL SCATTERING OF Li^+ IONS BY He, N_2, AND O_2 IN THE RANGE 3 TO 400 eV. Aberth, William; Lorents, Donald C. (Stanford Research Inst., Menlo Park, Calif.). Phys. Rev., 182: 162-7(June 5, 1969).

Absolute elastic differential cross sections have been measured for Li^+ on He, N_2, and O_2. In the center-of-mass system the collision energies range from 3.6 to 328 eV and the scattering angles from 1° to as high as 90°. An energy analysis was performed on the scattered Li^+ ion beam. The inelastic cross section for $Li^+ + He$ was less than 2×10^{-19} cm^2 sr^{-1} for all values of $E\theta$ measured up to 6000 eV deg. The analysis of the inelastic scattering of $Li^+ + N_2$ and $Li^+ + O_2$ shows some structure representative of the target molecule and indicates that inelastic scattering becomes the dominant process for $E\theta > 4500$ eV deg. The $Li^+ + He$ elastic cross sections are smooth and relatively structureless. Lack of any rainbow angle structure indicates that the attractive well depth of $LiHe^+$ is less than 0.2 eV. (auth)

27380 TOTAL CHARGE-TRANSFER CROSS SECTIONS FOR He^+ AND Ar^+ ON K, Rb, AND Cs: NEAR-RESONANT REACTIONS LEADING TO EXCITED FINAL STATES. Peterson, J. R.; Lorents, D. C. (Stanford Research Inst., Menlo Park, Calif.). Phys. Rev., 182: 152-61(June 5, 1969).

Total charge-transfer cross sections have been measured for He^+ and Ar^+ ions on K, Rb, and Cs atoms, using a crossed-beam arrangement. Ion-beam energies ranged from 10 to 1500 eV. The cross sections were all very large ($\gtrsim 50$ Å^2) for asymmetric reactions and give evidence of the anticipated importance of capture into excited states in near-resonant reactions. Predictions (for excited-state products) of a simple two-state theory provide qualitative agreement. (auth)

27381 PSEUDOPOTENTIAL METHOD FOR INELASTIC PROCESSES IN ATOMS AND MOLECULES. II. PHOTOIONIZATION OF N_2. Schneider, Barry; Berry, R. Stephen (Univ. of Chicago). Phys. Rev., 182: 141-51(June 5, 1969).

The pseudopotential method developed in Paper I is applied to the photo-ionization of N_2. From the known quantum defects of two Rydberg series of N_2, the phase shifts of the photoionized electron are obtained. These phase shifts are used to construct a simple model potential approximation to the true pseudopotential. The model wave functions are then orthogonalized to the known Hartree–Fock wave functions of the N_2^+ core. These wave functions are used to calculate the total and differential cross section for photoionization of N_2 as a function of the energy of the outgoing electron. The results of the calculation are discussed and compared with some of the more recent experimental measurements of the aforementioned quantities. (auth)

27382 DELAYED-COINCIDENCE STUDY OF $O^+ + Ar$ COLLISIONS AT 50 TO 200 keV. Bingham, Felton W. (Sandia Labs., Albuquerque, N. Mex.). Phys. Rev., 182: 180-96(June 5, 1969).

Delayed-coincidence techniques have provided measurements of the distributions in values of Q, the energy transferred to inelastic processes, during $O^+ + Ar$ collisions at 50 to 200 keV. As a function of decreasing r_0, the distance of closest approach of the colliding particles, the average values $\bar{Q}$ of the Q distributions increase rapidly. At 50 keV, for example, $\bar{Q}$ increases from 142 eV at r_0 of 0.26 Å to 707 eV at 0.07 Å. For fixed r_0 the $\bar{Q}$ values increase with bombarding energy and lie 150 to 200 eV higher at 200 keV. The Q distributions for r_0 between 0.11 and 0.20 Å consist of two overlapping symmetrical distributions. Although one of these two distributions lies as much as 215 eV above the other, measurements of the average charges of the oxygen ions after their collisions show that none of the extra energy goes into ionization of the beam particles. These distributions occur over the range of r_0 where penetration of the argon L electron shell is expected; differential cross sections for scattering of the oxygen ions also show structure in this region. The qualitative behavior of the Q distributions agrees generally with theoretical expectations. However, the energy differences between the centers of the two overlapping distributions do not agree with simple theoretical predictions, which also do not forecast the observed variation of these differences with r_0. (auth)

27383 FORMAL THEORY OF RESONANCE SCATTERING. Mittleman, Marvin H. (City Univ. of New York). Phys. Rev., 182: 128-32(June 5, 1969).

A formal theory of resonances is presented in the Feshbach formalism with the use of more general projection operators and the relationship with other resonance formulations is clarified. The resonance position and true width are defined. They depend upon the background or potential, scattering. An attempt is made to define the resonance state without using a "preconceived notion" of its structure. The attempt is not totally successful but the resultant equation is shown to be useful in obtaining corrections to other resonance formulations. (auth)

27384 CROSS SECTIONS FOR ELECTRON CAPTURE INTO THE EXCITED LEVEL n = 6 OF HYDROGEN BY 5- TO 70-keV PROTONS IN Mg VAPOR AND IN NEON. Berkner, Klaus H.; Cooper III, William S.; Kaplan, Selig N.; Pyle, Robert V. (Univ. of California, Berkeley). Phys. Rev., 182: 103-15(June 5, 1969).

An optical technique was used to investigate electron capture into the excited level n = 6 of hydrogen by 5- to 70-keV protons passing through magnesium vapor or neon. Photons from the Balmer H_δ transition, which are emitted downstream of the target, were analyzed with a grating spectrometer and counted. From these the population of the level n = 6 and the cross section for electron capture into n = 6 have been obtained. Cross-section estimates for ionization of the level n = 6 collisions with Mg atoms are also presented. The electron-capture cross sections are consistent with n^{-3} extrapolations of electric-gap measurements for capture into higher quantum levels (n ≈ 9 to 15) reported by Il'in and co-workers, Futch and Moses, and Riviere. The results are compared with those of various theoretical models. (auth)

27385 DEPENDENCE OF THE PHASE SHIFT ON ENERGY AND ATOMIC NUMBER FOR ELECTRON SCATTERING BY ATOMIC FIELDS. Manson, Steven Trent (National Bureau of Standards, Washington, D. C.). Phys. Rev., 182: 97-103(June 5, 1969).

Phase shifts of s, p, d, and f electrons scattered elastically by a potential appropriate to singly charged positive ions have been calculated for energies ranging up to 2 Ry above threshold and for selected elements throughout the periodic system. The results are discussed in terms of characteristics of the model potential. (auth)

Atomic Theory

27386 (AD-678181) ATOMIC PHYSICS AND MANY-PARTICLE INTERACTIONS. Final Technical Report. Watson, Kenneth M.; Schwartz, Charles L.; Kaufman, Allan M. (California Univ., Berkeley. Dept. of Physics). Oct. 23, 1968. 7p. (AFOSR-68-2020). CFSTI.

Studies conducted have investigated computational techniques in many-body systems of several types. These include relativistic two- and three-body equations of the Bethe–Salpeter type, atomic wave functions with correlations; helium fine structure; analyticity in scattering calculations. Several new techniques in numerical analysis, independent of any particular physical problem, have been found. Completed studies also include an analysis of the theory of cascade decays and of the scattering theory of composite particles. Publications covering these researches are referenced. Recent work includes developing techniques for studying atom–atom and ion–atom reactions using the eikonal approximation and evaluation of a recently completed theory of transport of electromagnetic radiation in a plasma. (auth) (USGRDR)

Cosmic Radiation

Refer also to abstracts 26537, 27230, 27254, 27456, and 27858.

27387 (AD-678640) A PROGRAM TO DETERMINE FUNDAMENTAL NUCLEAR DATA FROM MUON INTENSITY MEASUREMENTS AND TO INVESTIGATE GEOPHYSICAL ASPECTS OF COSMIC RAYS AT HIGH ENERGIES: INITIAL PHASE. Final Report. Sheldon, William R. (Houston Univ., Tex. Dept. of Physics). Jan. 1969. 14p. (AFOSR-68-2685). CFSTI.

A summary is presented of the results of the initial phase of an experimental program to measure absolute directional intensities of cosmic-ray muons from energies of a few BeV to approx. 1500 BeV. During this phase of the program an underground muon telescope was installed in the Mont Blanc tunnel and a magnetic momentum spectrometer was built at College Station, Texas; both of these instruments are presently in operation. In addition a second magnetic spectrometer was designed and the construction of this instrument has begun. Other activities include the design of apparatus to transform spark-chamber photographic data to a digital format and a review of theoretical calculations of processes which give rise to the muon flux. (auth) (USGRDR)

27388 (AD-681194) BOLIVIAN AIR SHOWER JOINT EXPERIMENT (CHACALTAYA COLLABORATION). Final Report, September 1, 1966–August 31, 1968. Koichi, Kamata; Toyoda, Yoshio; La Pointe, Martin; Suga, Koichi (Maryland Univ., College Park. Dept. of Physics and Astronomy). Dec. 28, 1968. 58p. (AFOSR-69-0102-TR). CFSTI.

The Bolivian Air Shower Joint Experiment (BASJE) is a cooperative effort of Japanese, Bolivian, and U. S. physicists to study the phenomena of cosmic-ray air showers under half an atmosphere. The experiment is set up on Mt. Chacaltaya near La Paz, Bolivia at an altitude of 17,600 feet above sea level. The prime motivation for the experiment has been that air showers generated by primary gamma rays (as opposed to ordinary showers generated by protons or heavier nuclei) could be detected and identified by peculiarities in the features of the showers observed. The air shower array was designed for this purpose and features a large (60 m^2) shielded detector and an accurate means of determining the arrival direction of the showers. A status report on the gamma-ray search is included. Two other efforts that have been of recent interest to the collaborators of the experiment are summarized. (USGRDR)

27389 (AWRE-O-64/68) RADIOLOGICAL DOSE TO THE SST CONCORDE FROM GALACTIC COSMIC RAYS. Fuller, E. W.; Clarke, N. T. (Atomic Weapons Research Establishment, Aldermaston (England)). Dec. 1968. 22p. Dep. CFSTI. UK 3s. 3d.

The radiological dose rate due to galactic cosmic rays was measured at a place of high geomagnetic latitude during the 1964 solar minimum to obtain the maximum value of the steady radiation level in which the SST Concorde will operate. Ionization chambers, neutron Rem meters, and nuclear emulsions carried to 65,000 ft by balloons were used for the measurements. It was concluded that the maximum value of the dose rate is 2.2 mRem/h and hence that the dose from galactic cosmic rays would not be a limiting factor in the operation of the Concorde. (auth) (UK)

27390 (N-69-11633) OBSERVATIONS OF COSMIC RAY ELECTRONS BETWEEN 2.7 AND 21.5 MeV. Simnett, G. M.; McDonald, F. B. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Nov. 1968. 33p. (NASA-TM-X-63393; X-611-68-450). CFSTI.

Results are presented from the IMP-IV satellite on the 2.7 to 21.5 MeV electron intensity in interplanetary space between July 3, and August 27, 1967. The measured electron intensity is believed to be uncontaminated by solar electrons. The analysis procedure for background subtraction and subsequent derivation of the electron spectrum is described. The results of electron accelerator calibrations are used extensively. The origin of the electrons is discussed, and the results are compared with the predicted intensity of knock-on electrons from proton–electron collisions in interstellar space. The measured electron spectrum is shown to be compatible with a sole origin in the galactic knock-on component if solar modulation of low energy electrons is insignificant. The electron energy spectrum obtained is well represented by a power law of the form $dJ/dE = 132\ E^{-1.75}$ electrons/m^2 sec sr MeV between 2.7 and 21.5 MeV. (auth) (STAR)

27391 (N-69-11950) PRIMARY COSMIC RADIATION. Status Report for Period Ending August 1968. Friedlander, M. W. (Washington Univ., St. Louis, Mo. Dept. of Physics). 17p. (NASA-CR-97781). CFSTI.

Details are given on the Barndoor series of high-altitude balloon flights which were equipped with large area detectors to search for primary cosmic-ray particles with $Z \geq 30$. For the three flights, the basic unit was a sandwich comprising a layer of nuclear photographic emulsion together with a number of plastics. The flight package consisted of several such sandwiches, stacked one above the other. To distinguish between those tracks recorded at ceiling and those recorded during ascent or descent, the relative positions of the sandwiches were changed when the balloons reached ceiling altitudes. Procedures for plastics processing, charge identification, and mechanical scanning are discussed. Another balloon flight carrying a scintillation–Cherenkov counter experiment designed to measure particles with $1 < Z \leq 26$ is also discussed, along with the problems associated with the data analysis. (STAR)

27392 (N–69-12960) THE RADIAL GRADIENT OF INTERPLANETARY RADIATION MEASURED BY MARINERS 4 AND 5. Krimigis, S. M.; Venkatesan, D. (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). 1968. 55p. (NASA-CR-97871). CFSTI.

The detector package on Mariner 4, which was launched on a Mars-bound trajectory on November 28, 1964, includes a shielded GM tube (detector C) whose threshold is about 50 to 55 MeV/nucleon for proton and alpha particles. By comparing the counting rate of detector C to that of a similar earth-orbiting GM tube on the IMP–OGO series of spacecrafts one finds the following: (a) As the difference in heliocentric longitude between the two spacecraft increases, there appear differences in the time and/or space development of a Forbush decrease (b) The gradient of particles in the interplanetary medium with energies above the detector energy threshold is directed towards the Sun. (c) Additional data from the Venus-bound Mariner 5 spacecraft and the Mariner 4 and IMP–OGO spacecrafts show that the gradient ranged from –24 to –29%/AU. (d) It is shown that the interplanetary flux of particles of $E > 50$ MeV/nucleon must in part be of solar origin. (e) It is argued that the gradient of galactic cosmic radiation of $E \approx 50$ MeV/nucleon cannot be measured even at the time of solar minimum. (auth) (STAR)

27393 (N–69-13271) SOURCE REQUIREMENTS FOR THE FLUCTUATION ORIGIN OF COSMIC RADIATION. Wayland, J. R. (Maryland Univ., College Park. Dept. of Physics and Astronomy). Sept. 1968. 37p. (NASA-CR-98515; TR-889). CFSTI.

Conditions placed upon a source of cosmic-ray particles within a model for the origin of cosmic rays, in which fluctuations in the momentum-changing process are important, were investigated. This is done by considering the relationship between $\langle \Delta p \rangle$ and $\langle \Delta p^2 \rangle$, where Δp is the momentum change in a collision. With the assumption that the energy due to turbulent motion, cosmic rays, and the magnetic field are linearly related, one finds an expression for the number density of cosmic-ray particles ejected from a changing volume in terms of their average kinetic energy. This is considered in terms of the fluctuation model to obtain other source requirements. It is found that, over a large range of astrophysical phenomena, the dominance of fluctuation can be important to the origin of cosmic radiation. (auth) (STAR)

27394 (N–69-15815) PRIMARY COSMIC-RAY ELECTRONS BETWEEN 17 MeV AND 1 GeV IN 1967. Israel, Martin H. (California Inst. of Tech., Pasadena). [1968]. 29p. (NASA-CR-99182). CFSTI.

Observations made from three balloon-borne detector flights from Fort Churchill, Manitoba on 17 June, 2 July, and 21 July are reported. The detector, consisting of a scintillation counter telescope, gas Cherenkov counter, and spark chamber with lead plates, floated near 2 g/cm^2 atmospheric depth for a total of 35 hours. The primary electron results depend critically upon the correction made for atmospheric secondary electrons. Data gathered during balloon ascents enables verification of a previously published calculation of atmospheric secondaries. At energies below 350 MeV, the observed electron flux can be entirely accounted for by atmospheric secondaries. Upper limits of 2 σ on the primary electron flux of 20, 9, and 13 electrons/m^2 sec ster are given in the energy intervals 17 to 57, 57 to 112, and 112 to 374 MeV, respectively. Between 374 and 1060 MeV, 16 ± 14 electrons/m^2 sec ster are found. Comparison between the observed upper limits to the primary flux and a calculation of the flux of galactic secondary electrons indicates an absolute solar modulation of electrons below 100 MeV by at least a factor of three. (auth) (STAR)

27395 (N–69-15908) COSMIC-RAY NEGATRON AND POSITRON SPECTRA BETWEEN 12 AND 220 MeV. Beuerman, K. P.; Rice, C. J.; Stone, E. C.; Vogt, R. E. (California Inst. of Tech., Pasadena). [1968]. 12p. (NASA-CR-99198). CFSTI.

The interplanetary negatron and positron spectra from 12 to 220 MeV were determined with a balloon-borne magnetic spectrometer. The observed charge ratio $e^+/(e^+ + e^-) \approx 0.3$ indicates that the flux most likely consists of a mixture of primary negatrons and interstellar secondary negatrons and positrons. An absolute solar modulation of the interstellar positron flux was determined which decreases with decreasing magnetic rigidity below about 80 MV. (auth) (STAR)

27396 (N–69-17996) PHOTODISINTEGRATION OF ULTRA-HIGH ENERGY COSMIC-RAYS BY THE UNIVERSAL RADIATION FIELD. Stecker, F. W. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Dec. 1968. 11p. (NASA-TM-X-63411; X-641-68-480). CFSTI.

A detailed calculation to determine the effectiveness of the universal radiation field in disintegrating ultrahigh–energy cosmic-ray nuclei is presented. It is concluded that this process cannot explain the air-shower observations above 10^{17} eV unless there exists a large metagalactic flux of infrared photons as may have recently been detected. Other implications of the results are discussed. (auth) (STAR)

27397 (N–69-18033) PREDICTION OF EXTRAGALACTIC GAMMA-RAY FLUXES BETWEEN 1 AND 100 MeV. Stecker, F. W.; Silk, Joseph (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Dec. 1968. 13p. (NASA-TM-X-63421; X-641-68-492). CFSTI.

The observed isotropic cosmic x and gamma rays may be produced by some combination of four possible types of extragalactic interactions. It is shown that spectra from these interactions have important distinguishing characteristics in the 1 to 100-MeV energy range. By normalizing the theoretical spectra to the observed intensities, theoretical intensities of metagalactic cosmic-ray protons and electrons needed to account for the observed radiation are determined. (auth)

27398 FLUCTUATION ORIGIN OF COSMIC RADIATION. Wayland, J. R. (Univ. of Maryland, College Park). Astrophys. Space Sci., 3: 357-64(Mar. 1969).

The origin of cosmic radiation in terms of a sudden injection of particles in time, momentum, and space was investigated. The appropriate boundary conditions for the various regions through which the particles pass were used. With all of the acceleration within a turbulent region, it was found that the observed spectrum is explained by a continuous deceleration in which statistical fluctuations dominate. This is contradictory to the usual assumptions in which fluctuations do not play an important part. It was found that the time-dependent solution has an exponent of the power law spectrum that varies weakly with the momentum and time. The steady-state solution shows the usual constant exponent. (auth)

27399 RADIO EMISSION OF FAST COSMIC IONS. Kaplan, S. A.; Tsytovich, V. N. (Gorky Radiophysics Inst., USSR. Lebedev Inst. of Physics, Moscow). Astrophys. Space Sci., 3: 448-63 (Mar. 1969).

It is usually assumed that the ions of cosmic rays contribute nothing to the observable electromagnetic radiation. However, this is true only when these ions are moving in a vacuum or a quiet (nonturbulent) plasma. In the case of fast ions in a turbulent plasma, there is an effective nonlinear mechanism of radiation which is discussed in this paper. The fast ion (relativistic or nonrelativistic) moving in the plasma creates a polarization cloud around itself which also moves with the particles. The turbulent plasma waves may scatter on the moving electric field of this polarization cloud. In the process of this scattering an electromagnetic wave with frequency is generated. Let ω_1 and k_1 be the frequency and wave vector of turbulent plasma waves, V is the velocity of the ion, and ϑ is the angle between the wave vector of electromagnetic radiation and the direction of the ion velocity. The method of calculating the probability of the conversion of plasma waves (k_1) into electromagnetic waves (k) by scattering on an ion with velocity V is described in detail. (auth)

27400 ELEMENTARY COMPOSITION AND ORIGINS OF PRIMARY COSMIC RADIATION. Koch, Lydie (CEN, Saclay, France). Bull. Inform. Sci. Tech. (Paris), No. 132, 61-80(Dec. 1968). (In French).

The nuclear cosmic radiation is placed within the framework of the whole cosmic radiation (electromagnetic, nuclear, and electronic) and observational data on the charge and energy composition of heavy cosmic-ray nuclei are reviewed. The astrophysical implications of these observations on the nature of the sources, the propagation modes, and the mean age of the radiation are discussed. In the framework of the problems to be solved the experiments being realized at Saclay are described. It is noted however, that the solution of these problems will need a new generation of more precise and sensitive experiments, together with improved knowledge on nuclear interactions and on the behavior of charged particles in turbulent plasmas. (auth)

27401 EFFECT OF WAVE-PARTICLE INTERACTIONS ON THE PROPAGATION OF COSMIC RAYS. **Kulsrud, Russell; Pearce, William P. (Princeton Univ., N. J.). Astrophys. J., 156: 445-69(May 1969).**

The interaction between galactic cosmic rays and Alfvén waves in the interstellar medium is investigated. They may interact adiabatically through magnetic mirror scattering or nonadiabatically through gyration frequency resonance. The equations describing the latter are derived. The growth rates for the waves are given, and the Fokker–Planck equation for the diffusion of cosmic rays in velocity space is derived. These two equations are applied to a model of the cosmic rays consisting of a uniform tube of magnetic field with open ends. An equation of spatial diffusion is derived in the limit of strong wave–particle scattering, and this equation is compared with the observed properties of the galactic cosmic rays to derive a mean free path for scattering of about 10 pc. It is shown that when the interstellar damping of the Alfvén waves is included, the waves are probably marginally stable. Finally, a self-consistent model is specified in which the sources of turbulence and cosmic rays are given and the cosmic-ray densities are to be determined. This model is solved in the crude approximation where all particles have effectively the same energy and all waves the same wavelength. It is shown that the cosmic rays can have an appreciable effect on their confinement to the Galaxy. It is shown that if the inhomogeneous distribution of mass is taken into account, the confinement of cosmic rays is determined primarily by the low-density regions between the clouds. An attempt is made to evaluate the efficiency of heating of cosmic rays, and it appears that their energy changes very little during their galactic confinement. However, because there is a nonlinear relation between the source and the cosmic-ray density, the observed energy spectrum does not necessarily represent the emitted spectrum. (auth)

27402 OBSERVATIONS OF FLUORINE NUCLEI IN THE PRIMARY COSMIC RADIATION MADE ON THE PIONEER 8 SPACECRAFT. **Lezniak, J.; Webber, W. R. (Univ. of Minnesota, Minneapolis). Astrophys. J., 156: L73-7(May 1969).**

Measurements with a counter telescope aboard the Pioneer 8 spacecraft have identified fluorine nuclei in the primary cosmic radiation. The fluorine abundance is 1 to 2% of oxygen in the energy range above 500 MeV nucleon^{-1}. This abundance is consistent with a fragmentation origin for these nuclei resulting from the passage of heavier cosmic rays through ~4 g cm^{-2} of hydrogen. (auth)

27403 PRODUCTION OF LOW-ENERGY (0.1 TO 10-MeV) POSITRONS IN THE COSMIC RADIATION. **Verma, Satya Dev (Louisiana State Univ., Baton Rouge). Astrophys. J., 156: L79-84(May 1969).**

It is shown that a large flux of positrons with energies below 10 MeV will be introduced into the cosmic radiation by the β-decay of certain isotopes of carbon, nitrogen, and oxygen produced in interactions of cosmic rays with interstellar hydrogen. Fluxes and energy spectra of the positrons are estimated to within an order of magnitude. The significance of this β-decay origin of cosmic-ray positrons is discussed. (auth)

27404 EVIDENCE FOR THE EMISSION OF ENERGETIC GAMMA RAYS FROM THE GALACTIC PLANE IN THE CYGNUS REGION. **Valdez, J. V.; Waddington, C. J. (Univ. of Minnesota, Minneapolis). Astrophys. J., 156: L85-9(May 1969).**

In the course of a search for the emission of energetic gamma rays, $E > 100$ MeV, from Cygnus A and Cygnus X-1, a small region of the galactic equator around $l(\text{II}) = 80°$ was surveyed. The detector used has an angular resolution of better than 0.02 rad and has been employed to look for evidence of a line source having an intensity of 2×10^{-4} photon $\text{cm}^{-2}\ \text{sec}^{-1}\ \text{rad}^{-1}$, similar to that recently reported from satellite observations. Using a balloon-borne detector one would expect to detect such a line source as having an intensity equal to or greater than that of the general atmospheric background if the width of the line source is <0.1 rad. This width is approximately equal to that of the distribution of the interstellar hydrogen deduced from the 21-cm radio emission and could thus represent the width of the gamma-ray source if the interstellar matter in this direction is optically thin to the 21-cm radiation. Evidence is presented for an apparent increase in intensity of about 2 standard deviations above the background level that is being emitted from the 0.1-rad strip centered on $b(\text{II}) = +1.5°$. The deduced intensity is consistent with that reported recently. That a similar intensity is being emitted from a line source much narrower than 0.1 rad would seem to be improbable. (auth)

27405 COSMIC-RAY RECORDS AND INTENSITY VARIATIONS DURING COSMIC RAY STORMS. Oestman, Bo. Abstracts of Uppsala Dissertations in Science, No. 129. Uppsala, Univ. of Uppsala, 1969. 9p.

Thesis.

The studies in this thesis deal mainly with long-term variations. The meson data do not permit a reliable study of such variations because of the poor correction for atmospheric effects. The meson data were still used as a means for outlining the methods of calculations. The study of the plastic scintillator telescopes describes a method of recording cosmic rays. However, these telescopes were constructed during a period of low solar activity thus giving very few records of cosmic-ray decreases. The choice of neutron monitor data from 1957–59 was caused by the great number of decreases recorded by many stations. (auth)

27406 RADIO PULSES FROM COSMIC-RAY AIR SHOWERS AT 44, 105, 239, AND 408 MHz. **Spencer, R. E. (Univ. of Manchester, Jodrell Bank, Eng.). Nature (London), 222: 460-1(May 3, 1969).**

It is stated that present theories predict that very little radio emission from extensive air showers will occur at frequencies greater than about 100 MHz, although radio pulses were observed by the Dublin group at 520 MHz. It was therefore of interest to examine the emission spectrum at high frequencies. The experiments reported confirmed and extended the results of the Dublin group. Details are given of the equipment employed and its method of operation. Nearly all showers that fell within the aerial beam-width at 239 MHz gave rise to detectable radio pulses, but the flux density decreased with frequency increase. The results indicate that coherence is progressively lost at wavelengths < 1 m; the observed continuation of emission to shorter wavelengths may, however, be related to the strength of incoherent radiation, which gives a flux density proportional to frequency. If the observations are showing a component of incoherent radiation, they suggest that radio pulses may be observed at frequencies much higher than hitherto considered. (UK)

27407 ALIGNMENT OF INTERSTELLAR GRAINS BY COSMIC RAYS. **Salpeter, E. E.; Wickramasinghe, N. C. (Inst. of Theoretical Astronomy, Cambridge, Eng.). Nature (London), 222: 442-4(May 3, 1969).**

It is suggested that the alignment of interstellar grains, required by the polarization of starlight, may result from the combined effects of radiation pressure from the central bulge of the galaxy, gas collisions, and isotropic bombardment by cosmic rays. (auth) (UK)

Direct Energy Conversion

27408 (AD-678083) THERMALLY DRIVEN ROSSBY-MODE HYDROMAGNETIC DYNAMOS. **Report No. Scientific-2. Gilman, Peter A. (Colorado Univ., Boulder). Sept. 1968. Contract F19628-67-C-0304. 67p. (AFCRL-68-0501). CFSTI.**

A new class of hydromagnetic dynamos is presented for which the fluid motions are large-scale Rossby waves in a zonal flow, driven by latitudinally nonuniform heating. The magnetic fields induced by these motions are allowed to react upon them, through electromagnetic body forces. The model actually solved is confined to a channel between latitude walls, has two layers in the vertical, and a small number of Fourier harmonics in the horizontal. It is a generalization of the nonmagnetic model developed by Lorenz to study vascillation, and of earlier work by the writer. Most of the dynamos found have periodically reversing magnetic fields; the period depends principally on the strength of the inducing motions. Fields in successive cycles increase until they are strong enough to alter the motion and thereby reduce induction, after which induction of new fields is balanced by dissipation, on the average. Magnetic energy typically reaches 10% of the kinetic energy of the inducing motions. Some nonreversing dynamos are also found. The results, including field amplitudes, periods of reversal, and particularly the process of field reversal compare reasonably well with observed properties of the solar cycle. (auth) (USGRDR)

27409 (ANL-7550, pp 74-92) ENERGY CONVERSION. **(Argonne National Lab., Ill.).**

Further studies were made on electrochemical cells and systems for conversion of thermal energy to electrical energy. The progress reported on the broadly based research program is grouped under: (A) Cells with Lithium Anodes. Data are included on the pressure–composition phase diagram and activity coefficients for the Li–Sn system at 1200°C; voltage–current density curves for a Li/Sn cell; phase studies from thermal analysis and x-ray-diffraction studies of the Li–Te system; phase studies of the LiCl–LiI–KI system; Raman spectra of the $MgCl_2$–KCl system at 550°C and of 1.5 M UO_2Cl_2 in $MgCl_2$–KCl–NaCl eutectic at 600°C; performance of Li/S cells with lithium halide liquid and paste electrolytes and of a Li/P cell with liquid lithium halide electrolyte; performance comparison of these two cells with earlier studies on Li/Se and Li/Te cells; and immobilization studies on lithium halide electrolytes. (B) Cells with Sodium Anodes. Data are presented on thermodynamics (activity coefficients and phase relationships) of the Na–Bi system by an emf method; and a more accurate solid–liquid phase diagram for the Na–Bi system from thermal analysis and solubility studies. (C) Materials Stability. Tests of three potential insulator materials, $LiAlO_2$, Li_2ZrO_3, and $CaZrO_3$ showed only $LiAlO_2$ to be suitably resistant to lithium attack; preliminary results on corrosion of metals by liquid selenium are inconclusive and will be extended; static corrosion tests of tungsten and various refractory alloys in liquid tin at 1300°C showed that only tungsten, Mo–30 wt % W, and Re–50 wt % tungsten appear to be suitable for construction materials in a lithium/tin thermally regenerative system. (L.M.T.)

27410 (EUR–4210) SECOND INTERNATIONAL CONFERENCE ON THERMIONIC ELECTRICAL POWER GENERATION, STRESA, ITALY, MAY 27–31, 1968. (European Nuclear Energy Agency, Paris (France). (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1440p. (In French and English). (CONF-680508). UK $20.00.

About 131 papers and the discussions following are presented on the following topics: converter performance, integrated systems for space and propulsion use, in-pile testing, heat pipes, materials, design and performance analysis, theory, plasma properties, surface phenomena, and work in U.S.S.R. They are written in English or French. A panel discussion, in which the thermionic programs of U.S. and U.S.S.R. are covered, is also included. An author index is included. (D.L.C.)

27411 (N–69–12307) OPERATION OF AN MGD POWER GENERATOR. Concluding Report, June 1–November 30, 1967. Townsend, Stanley J. (Toronto Univ. (Ontario). Inst. for Aerospace Studies). Oct. 24, 1968. 38p. (NASA-CR–72477). CFSTI.

A large, inert-gas, blowdown, magnetogasdynamic power generation facility was constructed to produce a large volume and mass flow rate of seeded argon or helium plasma and to dispose safely of the high-temperature, corrosive plasma after testing. The facility is versatile enough to apply this plasma to a wide variety of channel geometries with minimal changes in reconfiguration. With the completion of the installation and satisfactory testing of all components but the seedling and seed-removal systems, an increased effort is being placed on analytical and diagnostic studies of the plasma. A series of calculations was performed for a uniform flow of current through an infinite, argon/NaK-90 plasma, when the driving electric field is U × B. A later study extended this to a solution of Laplace's equation in the channel where the boundary conditions are prescribed by a combination of electrodes, insulators, and the free stream in the channel. Further modifications were introduced in this latter study to allow for strong gradients in electron temperature and pressure. (auth) (STAR)

27412 (N–69–14920) SIX-CONVERTER SOLAR THERMIONIC GENERATOR. Final Report, January 10, 1967–March 31, 1968. Athanis, T.; Shefsiek, P.; Lazaridis, L. (Thermo Electron Engineering Corp., Waltham, Mass.). June 1968. Contracts NAS7-100; JPL–951770. 110p. (NASA-CR–98712; TE–4073-146-68). CFSTI.

For Jet Propulsion Lab., Pasadena, Calif.

A six-converter solar thermionic generator was designed, fabricated, and subjected to preliminary evaluation. Six additional thermionic converters similar to those used in the generator were fabricated and individually tested. With the exception of one, each of the twelve converters produced more than 36 watts of output power at 0.7 volt output voltage, and at 2000°K emitter temperature. The average power output per converter was 37.5 watts. All converters have identical overall configuration, employing planar electrode geometry with a rhenium emitter (of about 2 cm^2 area), and a molybdenum collector separated by about 0.005 cm (2 mils) during operation. Critical parts of each converter and of the generator in general were subjected to detailed design analysis and performance evaluation. Heat flux distribution and temperature profiles, heat transfer mechanisms, and heat dissipation requirements in the generator were determined. (auth) (STAR)

27413 COMPARISON OF CHARACTERISTICS OF AN IDEAL INDUCTIVE MHD CONVERTER AT PRESSURE AND GENERATOR REGIMES TAKING INTO ACCOUNT THE CURRENT CONDUCTIVITY OF THE CHANNEL WALLS. Abritska, M. Yu.; Krishberg, R. R. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 1, 64-72(1969). (In Russian).

An ideal three-phase reactive MHD machine is considered. A comparison between the pressure and the generator regimes is carried out. Expressions for calculating the maximum output power and the developed pressure head are presented. The analysis presented enables one to evaluate the effect of the current-conductive walls of the channel in three-phase MHD generators where exact calculation is hampered. (auth)

27414 THERMOELECTRIC GENERATOR. (to Brown Boveri and Co. Ltd.). British Patent 1,151,420. May 7, 1969. Priority date Apr. 17, 1967, Switzerland.

A thermoelectric generator, using a semiconductor as the thermoelement material, is designed with a reliable seal of the thermoelement limbs from the oxidizing atmosphere. In the generator, the cold ends of the thermoelement limbs are soldered to pole pieces, while the hot ends are connected through contact units to a bridge piece. Protective tubes around the limbs are soldered to the bridge; they terminate just short of the pole pieces on the cold ends to leave an expansion gap, which is filled with silicone rubber. This seal, besides providing a permanent gas-tight seal, also allows thermal expansion of the limbs without strain. Insulating tubes are inserted between the limbs and the protective tubes. Thrust plates are provided for maintaining good electrical contacts, and for heating and cooling the respective ends. (D.L.C.)

27415 HIGH TEMPERATURE TECHNIQUES IN DIRECT CONVERSION OF ENERGY. Euler, K. J. (Varta AG, Frankfurt am Main). Chem.-Ing.-Tech., 41: 40-50(Jan. 1969). (In German).

Progress in static generation of electricity is impeded by problems concerning materials of construction at high temperatures. For galvanic fuel cells, electrolytes from molten alkali carbonates and from solid ionic conductors of the Nernst type were investigated. High-temperature metals, usually molybdenum, niobium, or rhenium, were used as electrodes in thermionic converters. Pure, dense, sintered corundum was used as insulator. Particular difficulties were encountered in the case of magnetohydrodynamic (MHD) converters, not only in the electrodes and walls in specific MHD channels but also in the air preheater. (auth)

Fluid Physics

27416 (AD–678626) VISCOUS MAGNETOHYDRODYNAMIC FLOWS. Sonju, O. K. (Stanford Univ., Calif. Inst. for Plasma Research). July 1968. Contracts AF49(638)–1123; F44620-68-C-0051. 157p. (SU-IPR–245; AFOSR–68-2620). CFSTI.

The effects in both fully developed, two-dimensional flows and boundary-layer flows of an applied transverse magnetic field and an applied parallel electric field (i.e., normal to both the flow and the magnetic field) on the dynamic behavior of electrically conducting fluids are investigated. The flow over electrically insulated walls are considered. The importance of fluid-property variations, particularly electric conductivity, in the plasma is studied. Both laminar and turbulent flows are discussed, and experimental as well as theoretical work was performed. The influence of the electric conductivity profile within the plasma is studied by systematically varying the wall temperature with respect to the mean plasma temperature. The effect of the magnetic field is found to be sensitive to this temperature difference. Furthermore, turbulence-damping effects, Hall-parameter effects, and fluid-property-variation effects are discussed. A complete correlation of the data is proposed. Significant changes due to the magnetic field are observed. The calculated boundary-layer thickness and wall friction approach asymptotic values at large distances downstream of the leading edge. The boundary-layer thickness decreases with increasing magnetic interaction. The effect of a varying electric conductivity in the boundary layer is also estimated. (auth) (USGRDR)

27417 (N–69–11839) ELECTROHYDRODYNAMIC CHARGE RELAXATION AND INTERFACIAL PERPENDICULAR FIELD INSTABILITY. Melcher, James R.; Smith, Charles V. Jr. (Massachusetts Inst. of Tech., Cambridge). Oct. 28, 1968. 36p. (NASA-CR–97765; CSR-TR–68-10). CFSTI.

The small-amplitude motions of a plane interface between two fluids stressed by an initially perpendicular electric field are investigated. The fluids are modeled as ohmic conductors and the convection of the surface charge caused by the dynamic interplay of interfacial electric shear stresses and the viscous stresses is highlighted. The influence of viscosity on instability growth rates in the zero-shear stress limits of perfectly conducting and perfectly insulating interfaces is described and compared to cases involving electrical shear stresses. Detailed attention is given to the instability of an interface between fluids having electrical relaxation times long compared to times of interest. It is shown that, for many common liquids, even a slight amount of surface charge makes the interface unstable at a considerably lower voltage than would be expected from theories based on the dielectrophoretic limit of no interfacial free charge. Experiments performed using high-frequency ac stresses, gradually increased dc fields, and abruptly applied dc fields support the theoretical model. Instability conditions for two liquids having short relaxation times are developed to show shear stresses are not important unless conductivities are the same order of magnitude. (auth) (STAR)

27418 DEGENERATION AND STABILITY OF MAGNETOHYDRODYNAMIC MODES IN A COAXIAL CHANNEL WITH AN HELICAL FIELD. Infeld, E. (Inst. of Nuclear Research, Warsaw). Acta Phys. Pol., 35: 549-56(Apr. 1969).

The eigenfrequency spectrum and stability of perfectly conducting inviscid and incompressible fluids confined to cylindrical channels and permeated by twisted magnetic fields is investigated. It is found that even when investigations are limited to axially symmetric instabilities, solutions can be found that are not stable. This happens for some azimuthal fields $B_\phi(r)$ and for waves longer than a given length. In one particular case, the flow fields are given as well as the exact values of the critical wave lengths. In this case, the instability is nonconvective and should therefore be easy to detect experimentally. (auth)

27419 DIRECT-INTERACTION APPROXIMATION OF MAGNETOHYDRODYNAMIC TURBULENCE. Groves, Richard Newland Jr. Lafayette, Ind., Purdue Univ., 1968. 120p.
Thesis.

The theory of turbulence in an incompressible, viscous, electrically conducting fluid is formulated using Kraichnan's powerful direct interaction approximation. A closed set of integro-differential equations are given for kinetic and magnetic response and covariance tensors in the time domain. A transformation to the wave-number-frequency domain yields a closed set of integral equations for these same tensors. Equations describing the important isotropic case are derived. These equations form a closed set of integral equations for the kinetic and magnetic response, normalized correlation, and energy spectrum functions. The triangle interactions or geometric coefficients which arise are developed in detail. Two characteristic approximations are considered which yield equations which present a reasonable numerical task without much loss in accuracy. Asymptotic solutions for kinetic and magnetic response, correlation, and energy spectrum functions are given for the high wave number inertial and dissipative ranges. Equipartition of energy is predicted in these ranges. The particular dependence of correlation functions on forcing correlation function explains an early dilemma of Kraichnan for ordinary turbulence. Asymptotic expressions for the kinetic and magnetic energy spectrum functions appear controversial in two important cases and provide motivation for a Lagrangian formulation to study this range. (Diss. Abstr.)

27420 STUDIES OF ELECTRIC ARC COLUMN IN A CHANNEL WITH GAS FLOW. Dautov, G. Yu.; Suyarov, N. Yu. (Inst. of Physics and Tech., Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk, No. 4, 64-7(1968). (In Russian).

Electric and thermal properties of an arc column were calculated using formulas obtained for an arc in a channel with a gas flow. The electric field intensity variations along the channel are functions of gas consumption and physical properties, channel dimensions, and radial distribution of heat-transfer properties. In the calculations it was assumed that the turbulent energy transfer is absent (i.e., $Re < 2000$), the relaxation time is shorter than the gas passage time across the arc, and the gas variations of gas pressure along the channel are negligible. (R.V.J.)

27421 HARTMAN PROBLEM FOR THE MOTION OF ELECTROCONDUCTING FLUID IN HOMOGENEOUS POROUS MEDIA. Ene, Horia I. (Inst. of Mathematics, Bucharest). Compt. Rend., Ser. A, 268: 564-5(Mar. 10, 1969). (In French).

A system of magnetohydrodynamic equations for porous media is deduced, and then the Hartmann problem is solved for homogeneous media. Results are obtained in good agreement with experiment. (tr-auth)

27422 TWO MODES OF MOMENTUM TRANSFER FOR A STATIONARY ARC IN A TRANSVERSE MAGNETIC FIELD. Giannotta, Salvatore F.; Schrade, Herbert O. Res. Rev. (Office Aerosp. Res.), 7: No. 8, 13-15(Aug. 1968).

Many intermediate transfer modes and combinations of flow patterns are possible in arc columns; the surface boundary and axial momentum modes discussed here represent, more or less, extreme cases. (L.M.T.)

Geophysics (Upper Atmosphere)

Refer also to abstracts 26626, 27294, 27309, and 27312.

27423 (AD-676993) AN INVESTIGATION OF F2 REGION IONOSPHERIC BEHAVIOR BY COMPUTER METHODS. Fritz, James H.; Yeh, K. C. (Illinois Univ., Urbana. Electrical Engineering Research Lab.). Aug. 1968. Contract F19628-67-C-0028. 91p. (TR-35; AFCRL-68-0419). CFSTI.

This is an investigation of the solution of the continuity equation modeled for the F2 region of the ionosphere. Since a numerical method is used to obtain the solution on a digital computer, variations of the model and their effects on the solution for electron densities are all investigated. Several current suggestions for explanations of some of the ionospheric anomalies are studied in this manner. (auth) (USGRDR)

27424 (AD-677328) INVESTIGATION OF PARTIALLY REFLECTED ECHOES FROM THE D-REGION OF THE IONOSPHERE. Cole, A. R. (Pennsylvania State Univ., University Park. Ionosphere Research Lab.). Dec. 1, 1968. 93p. CFSTI.

An experiment designed to enable observation of weak echoes, partially reflected from scatterers in the D region, is described. The basic theory of partial reflections, including the manner in which electron density profiles are obtained, is presented along with an examination of some of the assumptions which the theory makes. The equipment developed to perform the partial reflection experiment is described in detail. (auth) (USGRDR)

27425 (AD-678877) OBSERVATIONS OF ACOUSTIC WAVES IN THE IONOSPHERE FOLLOWING NUCLEAR EXPLOSIONS. Baker, Donald M. (Space Disturbances Lab., Boulder, Colo.). Oct. 1968. 54p. (SDL-5; ERL-89). GPO $0.55.

During 1961 and 1962 wavelike disturbances were observed in the ionosphere above the United States following seventy-five nuclear explosions in the atmosphere. The disturbances, which were detected at 150 to 200 km, had characteristic periods of about 1 min and speeds of about 300 m/s. In general an explosion must have a yield equivalent to 1 megaton of TNT or greater to generate a disturbance detectable at 7000 km from the source. The periods and propagation speeds of the ionospheric disturbances are essentially the same as those observed on the ground with microbarographs. The ionospheric disturbances are interpreted as manifestations of imperfectly ducted acoustic waves. A method is developed for relating the ionospheric-disturbance observations to the pressure perturbation in the neutral atmosphere. For one specific event (October 30, 1962) an upper limit to the relative pressure perturbation at 190 km is found to be 13%. A complete catalog of the nuclear explosions detected is given. (auth) (USGRDR)

27426 (AD-678999) AN ANALYSIS OF SUDDEN IONOSPHERIC DISTURBANCES ASSOCIATED WITH THE PROTON FLARE OF 0026 UT, JULY 7, 1966. Donnelly, R. F. (Space Disturbances Lab., Boulder, Colo.). Oct. 1968. 65p. (SDL-3; ERL-86). GPO $0.65.

The x-ray and extreme ultraviolet radiation deduced from sudden ionospheric disturbances are discussed for the solar flare of 0026 UT, July 7, 1966. The sudden frequency deviation for this event has the largest duration of all SFD's observed at Boulder. (auth) (USGRDR)

27427 (AD-679149) ENERGETIC ELECTRONS AT LATITUDES ABOVE THE OUTER ZONE CUTOFF. Vampola, Alfred L. (Aerospace Corp., El Segundo, Calif.). Oct. 1968. Contract F04701-68-C-0200. 55p. (TR-0200(4260-20)-1; SAMSO-TR-68-425). CFSTI.

Measurements made by a nine-channel magnetic spectrometer (energy range 225 keV to 2.47 MeV) on the polar-orbiting vehicle OV3-3 (1966-70B) indicate that energetic electrons from solar flares have access to the polar zones. Electrons were observed at invariant latitudes above the outer zone cutoff during the periods August 29, to September 6, 1966, January 31, to February 8, and May 25, to June 15, 1967. Isotropic fluxes with no spatial structure were observed over the entire polar zone sampled. Fluxes were independent of altitude over the range of 400 to 4000 km and between 0.13 and 0.48 gauss. Exponential decays of 0.67 and 0.80 days were observed for the August 29, and September 2, 1966, events. Typical spectra could be fit with power law functions with exponents between 3.0 and 3.6 for these two events. The January–February period in 1967 exhibited much harder electron spectra, with an exponential function providing the best fit with E_0 between 285 and 425 keV. Subsolar and antisolar polar flux merges with outer zone flux were distinctly different during the early phase of an event. (auth) (USGRDR)

27428 (AD-680983) MODIFICATION OF THE IONOSPHERE. Surveys of Foreign Scientific and Technical Literature. Michaels, Daniel W. (Library of Congress, Washington, D. C. Aerospace Technology Div.). Dec. 30, 1968. 71p. (ATD-69-11-101-1). CFSTI.

Experiments in ionospheric modification, i.e., the introduction of chemical or radioactive agents into the ionosphere for the purpose of altering electron concentrations and thus ionization levels, have been conducted by the USSR, the US, and Britain in order to develop methods of ensuring communications reliability of friendly forces and disrupting enemy communications in the event of war. Primary attention in this report is focused on Soviet interest in the single most important such experiment, namely, the study of the effects of a nuclear burst at a given height on radar and radio-wave propagation characteristics. Other nonnuclear, but germane, experiments as, for example, investigations of ray paths in artificially created ionized clouds, are also discussed. (auth) (USGRDR)

27429 (AD-681006) INITIAL OBSERVATIONS OF GEOMAGNETICALLY TRAPPED PROTONS AND ALPHA PARTICLES WITH OGO-4. Progress Report. Report No. 68-65. Fritz, T. A.; Krimigis, S. M. (Iowa Univ., Iowa City. Dept. of Physics and Astronomy. Johns Hopkins Univ., Silver Spring, Md. Applied Physics Lab. National Research Council of Canada, Ottawa (Ontario)). Dec. 1968. Contracts Nonr-1509(06); NAS5-3097. 60p. CFSTI.

The University of Iowa detector package on board the OGO-4 satellite, which was launched into a near polar orbit on July 28, 1967, includes two totally depleted solid state detectors with thickness of 34 and 7.2 microns designed to measure protons and alpha particles, respectively. Results, based on data obtained on August 8 and 27, 1967, show the following: The j_α/j_p ratio is 0.0007 and 0.0002 for particles of E > = 0.35 and 0.46 MeV/nucleon, respectively. The proton energy spectrum is well represented by a simple exponential spectrum. Comparison of the data with various predictions of models which consider the solar wind as source of trapped particles shows that there are serious discrepancies between theory and observations, and that possible differential loss mechanisms for protons and alpha particles must be examined in detail. (USGRDR)

27430 (AD-681007) SOME OBSERVATIONS ON ENERGETIC ELECTRONS IN THE OUTER VAN ALLEN ZONE DURING AURORAL SUBSTORMS IN RELATION TO OPEN AND CLOSED FIELD LINES. Progress Report. Report No. 68-66. Rao, C. S. R. (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). Dec. 1968. Contract Nonr-1509(06). 16p. CFSTI.

Data regarding the high-latitude boundaries and fluxes of electrons >40 keV in the midnight sector of the outer Van Allen zone during periods of auroral substorm activity were studied. It was observed that, during the expansive phase of a substorm, there is a large increase in flux but the boundary remains at the quiet time value (~68°). A simultaneous study of the latitudinal variation of the substorm activity indicates that its onset takes place at a latitude much lower than that of the outer zone boundary. From this it is concluded that the onset of auroral substorm activity takes place on closed magnetic field lines. (auth) (USGRDR)

27431 (AD-681151) TRAPPED ENERGETIC ALPHA PARTICLES IN THE OUTER RADIATION BELT. Paulikas, George A.; Blake, J. Bernard; Freden, Stanley C. (Aerospace Corp., El Segundo, Calif.). Nov. 1968. Contract F04701-68-C-0200. 30p. (TR-0200(4260-20)-3; SAMSO-TR-68-471). CFSTI.

Alphas with energies greater than 4.4 and 8.2 MeV were detected in the outer radiation belt (near L = 3.0) with a counter telescope. These measurements were carried out in August 1966 aboard the near polar elliptical OV3-3 satellite (1966-70A). (auth) (USGRDR)

27432 (CSIR-263) AN INVESTIGATION INTO THE EFFECT OF TEMPERATURE CHANGE ON THE F REGION ELECTRON DENSITY DISTRIBUTION IN THE SOUTH ATLANTIC GEOMAGNETIC ANOMALY. Torr, D. G.; Torr, Marsha R. (Council for Scientific and Industrial Research, Pretoria (South Africa). National Inst. for Telecommunications Research). 1967. 19p. Dep.

A possible explanation for the decrease in f_0F_2 observed by various workers at stations in the South Atlantic Geomagnetic Anomaly is put forward. The authors show that the neutral gas temperature distribution in the atmosphere can be represented by a hyperbolic function, which gives a much better fit to actual conditions than the usual linear temperature gradient. The theory of layer formation is revised using this function to represent the temperature. To calculate values of the electron density N in the F region under the influence of ambipolar diffusion the authors find that they must solve a second order nonlinear differential equation, and a method is developed for doing this. Finally they show that when a realistic function is used to represent the neutral gas temperature, an increase of about 400°K in the exospheric temperature decreases N_{max} by a factor of 2 to 3, if the intensity of ultraviolet radiation beyond the atmosphere and the solar zenith angle are kept constant. The conclusion is drawn that this is due to an increase in the loss rate, because of a corresponding increase in the number densities of the constituents N_2 and O_2. (auth)

27433 (LA-3929) THE 1967 LASL-SANDIA ROCKET-BORNE STUDY OF VACUUM ULTRAVIOLET AND VISIBLE EMISSIONS IN AURORAS. Theobald, Karl; Peek, H. Milton (Los Alamos Scientific Lab., N. Mex.). Feb. 10, 1969. Contract W-7405-eng-36. 11p. Dep. CFSTI.

Visible and vacuum ultraviolet emissions in an International Brightness Coefficient II aurora were measured in a joint Los Alamos Scientific Laboratory—Sandia Corporation rocket-borne experiment. The rocket payload was carried in a 12-in. Nike–Tomahawk to 167-km apogee at the Churchill Research Range, Fort Churchill, Manitoba, at 2147 CST on February 27, 1967. Instrumentation consisted of a scanning spectrometer for the 1150- to 1650-Å wavelength range; a filter-wheel photometer for 3914-Å first negative N_2^+, 4059-Å second positive N_2, and 5577- and 6300-Å atomic oxygen; and an electron spectrometer that failed. Good altitude profiles were obtained for all wavelengths until the filter-wheel photometer failed at 140 km. This is the first good profile achieved for the Lyman–Birge–Hopfield N_2 system in an aurora. The total maximum photon flux density in this system was derived from five observed bands. From the 3914- and 4059-Å data, the total maximum flux densities were derived for the first negative N_2^+ and second positive N_2 systems. The total measured photon flux in the vacuum ultraviolet was roughly equal to that in all visible bands and lines, indicating substantially greater energy radiated in the ultraviolet. Emissions at 3914, 4059, and 5577 Å have the same altitude dependence. When corrected for absorption by O_2, the Lyman–Birge–Hopfield emission has the same altitude dependence as N_2^+ first negative. Comparison of measurements with calculations leads to the conclusion that cascading through the Janin and Gaydon–Herman bands into the upper state of the Lyman–Birge–Hopfield bands was not significant in this aurora. Emission from atomic oxygen at 5577 and 6300 Å does not come mainly from direct electron impact excitation, but the principal mechanisms are unknown. (auth)

27434 (N-69-10466) ELECTRON MEASUREMENTS BEARING ON THE ENERGY AND PARTICLE BALANCE OF THE UPPER F-REGION. Brace, L. H.; Mayr, H. G.; Findlay, J. A. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Sept. 1968. 27p. (NASA-TM-X-63382; X-621-68-383. CFSTI.

Electron temperature and density profiles measured between 120 and 630 km at midday at Wallops Island on March 2, 1966 are presented and interpreted. The temperature profile exhibits a strong positive gradient (24°/km) below 150 km followed by a smooth transition to a much smaller positive gradient (1.5°/km) above 300 km. Between 300 and 400 km, the electron density decreases with a scale height of about 100 km, which is significantly lower than the diffusive-equilibrium scale height for the observed temperatures. Furthermore, the scale height more than doubles between 400 and 500 km. This change in scale height in a region where the mean ion mass and the electron temperature are nearly constant is also inconsistent with diffusive equilibrium and suggests that some dynamic process was occurring at the time of the flight. A simultaneous solution of the particle and energy continuity equations for the F region is carried out with the aid of inputs and boundary conditions from measurements of neutral composition, neutral gas temperature, and ion composition from the same vehicle. This analysis permits one to conclude that the upper F region was not in diffusive equilibrium between 300 and 500 km and that the low plasma scale height at these altitudes was consistent with either a neutral atmospheric wind or a rapid temporal variation in O^+. (auth) (STAR)

27435 (N-69-10508) LOW-ENERGY ELECTRON PRECIPITATION PATTERN AT HIGH LATITUDES. Hoffman, R. A. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Nov. 1968. 29p. (NASA-TM-X-63385; X-612-68-416). CFSTI.

From a consideration of all data available from satellite-borne detectors measuring low-energy electrons, an electron precipitation pattern at very high latitudes for periods of relatively low magnetic activity is formulated. From midnight through the dawn side until at least local noon, auroral oval latitudes are characterized by a broad, structureless precipitation, with the electrons having a hard-energy spectrum and a pitch-angle distribution which is almost isotropic over the upper hemisphere. Poleward of this region, although somewhat overlapping and apparently at all local times, there is a region of bursts or spikes of electrons with usually a very soft-energy spectrum. At pre-midnight times highly structured electron precipitation occurs with rapidly varying spectra. Very little precipitation is observed near the magnetic pole. (auth) (STAR)

27436 (N–69–10565) RELATION OF ENERGETIC PARTICLES IN THE PLASMA SHEET TO THE AURORAL ZONE. Anderson, K. A. (California Univ., Berkeley. Space Sciences Lab.). July 1968. Contract NAS-5-9077. 19p. (NASA-CR–97612). CFSTI.

A review is presented on the observational evidence for a relationship between plasma and energetic particle phenomena in the geomagnetic tail and precipitation of particles into the auroral zone. The properties of the plasma and energetic particles in the geomagnetic tail are summarized, along with the properties of the particles accelerated in the plasma sheet. Figures are included to show (1) the spatial extent of the plasma sheet as determined by Vela and OGO spacecraft; (2) examples of energetic electron fluxes in the plasma sheet 60 R_E into the tail; and (3) comparisons of particle fluxes observed in the geomagnetic tail with riometer records, and of particle fluxes 60 R_E into the magnetotail with ground level measurements. It is pointed out that electron precipitation into the auroral zone during substorms shows the same temporal behavior as island fluxes, and that the peak flux of plasma sheet acceleration events decreases with radial distance. (STAR)

27437 (N–69–10728) ION, ELECTRON, AND NEUTRAL TEMPERATURES DERIVED FROM ION COMPOSITION DISTRIBUTION. Rao, B. C. Narasinga (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). May 1968. 12p. (NASA-TM-X–63380; X–615-68-184). CFSTI.

The positive ion mass spectrometer aboard the Argo D-4 rocket was used to measure the ionic constituents O^+, N^+, H^+, He^+, NO^+, and O_2^+. The measurements showed O^+ as the major constituent throughout the altitude range of 200 to 630 km. Based on diffusive equilibrium, an equation is given for determining the distribution of an ionic species X^+ in an ion mixture having a mean ionic mass. Using this equation, a formula is obtained to derive ion temperature (T_i) from the height gradient of the ratio of $n(X_1^+)$ and $n(X_2^+)$ if both of them are in diffusive equilibrium. The values of T_i and its height variations are used to derive the electron temperature (T_e), and an equation is presented for determining the geopotential scale height of the electron density distribution under diffusive equilibrium. Ways of obtaining the neutral temperature (T_n) are mathematically defined. (STAR)

27438 (N–69–11454) STUDIES OF LOWER IONOSPHERE DRIFTS BY THE THREE-RECEIVER TECHNIQUE. Its Aeronomy Report No. 27. Guha, D. (Illinois Univ., Urbana. Aeronomy Lab.). Aug. 15, 1968. 83p. (NASA-CR–97768). CFSTI.

Described is a simple method for determining the ionospheric drifts by the three receiver technique. A description is given of the equipment used for measurements, and results of measurements taken during the summer months in 1967 are presented. (auth) (STAR)

27439 (N–69–11535) EXPLORER 12 MAGNETOPAUSE OBSERVATIONS: LARGE SCALE NONUNIFORM MOTION. Kaufmann, Richard L.; Konradi, Andrei (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Nov. 1968. 47p. (NASA-TM-X–63392; X–612-68-448). CFSTI.

A number of events have been studied which involve brief reentries of Explorer 12 into the magnetosphere when the satellite appears to be located well·beyond the equilibrium magnetopause position. The inverse behavior involving brief emergences of the satellite from the magnetosphere when the satellite appears to be located well below the equilibrium magnetopause position has also been investigated. The events studied provide evidence that relatively small portions of the magnetosphere occasionally become severely distorted. It is concluded that a bump or a wave-like structure appears on the magnetopause. Those structures producing the largest distortions are generally elongated in the north—south direction, and in most cases, the magnetosheath magnetic field is either nearly parallel or nearly anti-parallel to the magnetospheric field. As a result, the distortions do not involve severe bending of any magnetic field lines. The distortion frequently appears to be triggered by a change in the properties of the solar wind. (auth) (STAR)

27440 (N–69–12301) ANALYSIS OF SATELLITE DATA FOR STUDIES RELATED TO IONOSPHERIC PLASMA RESEARCH. Semiannual Status Report, May 1, 1967–April 30, 1968. Bettinger, R. T. (Maryland Univ., College Park. Dept. of Physics and Astronomy). 8p. (NASA-CR–97763). CFSTI.

Research programs investigating ionospheric plasma data analysis are briefly described. Several aspects of the interaction of the space vehicle in the ionospheric plasma are under study, and the first results on calculating the flux and angular distribution of ions to the satellite surface are reported to be complete. Preliminary calculations on the velocity axis response of an ion mass spectrometer indicate that the data may be a sensitive indicator of ion temperature. Several problems associated with Langmuir-probe modulation aspects are outlined. Plans for ion mass measurements, cylindrical Langmuir probe analysis, and satellite wake structure studies are mentioned. (STAR)

27441 (N–69–13636) DIURNAL SURVEY OF THE THERMOSPHERE. Final Report. Taeusch, D. R.; Carignan, G. R.; Nagy, A. F.; Niemann, H. B. (Michigan Univ., Ann Arbor). Nov. 1968. Contract NAS8-20232. 145p. (NASA-CR–61481). CFSTI.

The results of the launchings of eight Nike–Tomahawk sounding rocket payloads are summarized. The purpose of the payloads was to study the variability of the Earth's atmospheric parameters in the altitude region between 120 and 350 km. The payloads each included an omegatron mass analyzer, an electron temperature probe, and an aspect determination system consisting principally of a lunar or a solar sensor. This complement of instruments permitted the determination of the molecular nitrogen density and temperature, the electron density and temperature, and the ion density in the altitude range of approximately 140 to 320 km over Cape Kennedy, Florida. Six of the payloads were launched for the purpose of establishing the diurnal variation of the thermosphere under relatively quiet solar activity levels. The additional two payloads were launched as a follow-on day–night pair to reestablish the maximum–minimum density and temperature values for this day. (auth) (STAR)

27442 (N–69–13913) RELATION OF THE WESTWARD DRIFT OF THE GEOMAGNETIC FIELD TO THE ROTATION OF THE EARTH'S CORE. Richmond, A. D. (RAND Corp., Santa Monica, Calif.). Dec. 1968. Contract NASr-21(05). 24p. (NASA-CR–98603; RM–5861). CFSTI.

The concept of equating the drift of the geomagnetic field with a similar drifting motion of the Earth's core is examined. The drift of the field at the Earth's surface and at the core is calculated, and the two values are shown to be considerably different. Analysis of the portion of secular change remaining after westward drift effects have been removed is used to provide an estimate of the error in the drift which results from equating the drift of the field to that of the core. On this basis, the best estimate of the westward drift of the core for epoch 1960 is found to be 0.13° per year, with an estimated error of ±0.03°/yr. This drift is considerably smaller than the values usually cited for the core's rotation, such as 0.18° per year obtained by Bullard and others, based mainly on charted differences in surface data. (auth)

27443 (N–69–14272) DESCRIPTION OF SPACE SIMULATION EXPERIMENTS UTILIZING PLASMA PRODUCED BY CONTACT IONIZATION. Quinn, R. G. (Pennsylvania State Univ., University Park. Dept. of Electrical Engineering). Dec. 30, 1968. 23p. (NASA-CR–98667; SR–331). CFSTI.

A number of experiments utilizing thermally ionized plasmas for laboratory simulation of terrestrial plasma phenomena are discussed. It is shown that most of the essential features of the dynamics of charged particles trapped in the Earth's field can be simulated in the laboratory. Further, it is possible to systematically and in a controlled manner violate the various adiabatic invariants of the motion by causing perturbations through electric and magnetic fields and collisions. It is also shown that the conditions important for wave phenomena in the Earth plasma can be simulated in the laboratory. The size of the experimental apparatus will vary with the particular phenomena one wishes to simulate but even in the largest case is still experimentally feasible. A few clarifying remarks concerning the proper relation of laboratory simulation experiments with theoretical and experimental space research are also made. (auth) (STAR)

27444 (N–69–14773) DETAILED ANALYSIS OF RADIATION DATA FROM THE GEMINI 4 AND GEMINI 7 PROTON–ELECTRON SPECTROMETER EXPERIMENTS. Final Report, June 13, 1967–December 30, 1968. Reagan, J. B.; Heinemann, M. A.; Bakke, J. C.; Imhof, W. L. (Lockheed Missiles and Space Co., Palo Alto, Calif. Research Labs.). Contract NAS9-7030. 96p. (NASA-CR–92444; LMSC–682411). CFSTI.

The results of the data analysis performed on information obtained from two radiation spectrometer experiments conducted on the Gemini IV and Gemini VII spacecraft in June and December 1965 are described. Omnidirectional fluxes and spectra of electrons in the 0.45- to 6.0-MeV energy range and of protons in the 23.5- to 80-MeV energy range, as well as the omnidirectional proton flux greater than approximately 64 MeV were measured by scintillation spectrometers employing 16-channel pulse-height analyzers. Omnidirectional fluxes of both electrons and protons as a function of the magnetic field intensity, B, for specific L shells are presented along with the resulting flux contours in B, L space. Detailed electron and proton spectra as a function of L shell are also presented. Comparison of the present results with both theoretical and other experimental results is included. A direct measurement of the flux and spectra of the east–west asymmetry of trapped protons at low altitudes was performed on the Gemini IV experiment. A discussion of the measurement and its implications on the source and decay of trapped protons in the inner radiation belt is also presented. (auth) (STAR)

27445 (N–69-14803) CHANGES IN THE UPPER IONOSPHERE DURING SEVERE MAGNETIC STORMS. Mack, D. G. (Pennsylvania State Univ., University Park. Dept. of Electrical Engineering). Sept. 30, 1968. 98p. (NASA-CR-98707; SR-325). CFSTI.

Employing ionograms from the Alouette I topside sounder satellite, the moderately severe magnetic storms of June 15, 1965 and March 8, 1963 were investigated. Latitudinal contours of N(e) and vertical scale height revealed the disappearance of the geomagnetic anomaly during high magnetic activity, with a distinct correlation between Kp and the collapse of the anomaly being suggested. Storm-time variations of N(e) were found to be dependent upon the phase of the magnetic storm. Consistently reduced values of the storm-time vertical scale heights were interpreted as indicating an increase mean ionic mass due to an increased mixing of the ionosphere. (auth) (STAR)

27446 (N–69-15723) ALBEDO ELECTRONS BETWEEN 12 AND 1000 MeV. Israel, Martin H. (California Inst. of Tech., Pasadena). [1969]. 36p. (NASA-CR–99192). CFSTI.

The flux of splash albedo electrons near Fort Churchill, Manitoba, on July 9, 1967, was measured. A directional electron detector, consisting of a scintillation-counter telescope, a gas Cherenkov counter, and a spark chamber with lead plates, was flown on a balloon near 2 g/cm^2 atmospheric depth and pointed toward the nadir. Fluxes of 94 ± 16, 47 ± 11, 27 ± 9, and 2^{+4}_{-2} electrons/m^2 sec sr in the energy intervals 12 to 50, 50 to 100, 100 to 350, and 350 to 1000 MeV, respectively were observed. Return albedo electrons near Palestine, Texas, in a balloon flight near 5 g/cm^2 atmospheric depth on April 7, 1967 were also observed. Between 25 and 65 MeV 60 ± 26 return-albedo-electrons/m^2 sec sr were found. At higher energies the observed flux of downward moving electrons is consistent with being atmospheric secondaries. These return albedo fluxes are significantly lower than corresponding fluxes previously reported by Verma but are consistent with results of a calculation by Bland. Comparison between the observations at Fort Churchill and those at Palestine indicate a significant contribution to the splash albedo flux from primary particles with rigidity below 4.5 GV. (auth) (STAR)

27447 (N–69-17412) SOLAR X-RAY CONTROL OF THE E LAYER OF THE IONOSPHERE. Sengupta, P. R. (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). Jan. 1969. 46p. (NASA-CR–73884). CFSTI.

Solar x-ray control of the E layer of the ionosphere is investigated. Electron production rates between 100 and 140 km above the Earth due to 31- to 100-Å solar x-ray flux extrapolated from x-ray data recorded by Explorer 30, OGO-4, and OSO-4, and due to reported Lyman alpha flux from rocket and satellite experiments are calculated to show that about 70% of the E-layer ionization is contributed by the x rays. Calculated E-layer electron densities due to solar x-ray flux on two typical days are compared with the E-layer electron density profile. It is concluded that 31 to 100 Å solar x-rays which contribute about 70% of the E-layer ionization on a day of moderate solar activity are responsible for day-to-day variations in the E-layer index. Contribution of 10 to 30 Å solar flux to the E-layer ionization is small except on a day of high solar activity. (auth) (STAR)

27448 (N–69-17933) COMPARISON OF RESULTS OF EXPLORER 21 DIRECT MEASUREMENT PROBE. Donley, J. L.; Brace, L. H.; Findlay, J. A.; Hoffman, J. H.; Wrenn, G. L. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). July 1968. 31p. (NASA-TM-X–63442; X–615-68-290-A). CFSTI.

Intercomparison measurements of the major ionospheric parameters of ion and electron density and temperature and ionic species made by direct measurement probes on the Explorer XXXI satellite are presented. Plasma density results are compared with simultaneous data from the Alouette II satellite. Probe results are from the following experiments: planar ion trap, planar electron trap, cylindrical electrostatic probes, high-resolution magnetic ion mass spectrometer, planar Langmuir plate, and spherical ion probe. The plasma density measured by the various probes generally agrees with simultaneous Alouette II sounder values to within 20%. Electron temperatures measured by three different types of probes generally agree within 10%. Ion composition measurements by the planar ion trap and spherical probe show good agreement with the high-resolution magnetic mass spectrometer. Ion temperature measurements from the ion trap are consistently higher than spherical ion probe results. (auth) (STAR)

27449 (N–69-17995) BOW SHOCK ASSOCIATED WAVES OBSERVED IN THE FAR UPSTREAM INTERPLANETARY MEDIUM. Fairfield, D. H. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Nov. 1968. 42p. (NASA-TM-X–63409; X–616-68-454). CFSTI.

Fifty orbits of Explorer 34 data were used to study .01- to .05-Hz transverse waves in the interplanetary medium region between the bow shock and the spacecraft apogee of 34 R_E. It is concluded that the waves are associated with the Earth's bow shock since they only occur when projection of the interplanetary field observed at the spacecraft intersects the shock. The waves are observed 18.5% of the time when a total of 134 days of interplanetary data is considered, but more than 90% of the time when the field has the proper orientation with respect to the bow shock. On the basis of this result it is suggested that these waves with 20- to 100-sec periods are a permanent feature of the solar wind–Earth interaction. The transverse component of the waves is typically several gammas in amplitude in 4 to 8 gamma fields. The disturbance vector in the XY plane generally exhibits the same sense of rotation in a coordinate system where the field is oriented along the positive z axis. (auth) (STAR)

27450 (N–69-17997) DIURNAL AND SEASONAL VARIATION OF ATMOSPHERIC ION COMPOSITION; CORRELATION WITH SOLAR ZENITH ANGLE. Brinton, H. C.; Pickett, R. A.; Taylor, H. A. Jr. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Oct. 1968. 32p. (NASA-TM-X–63443; X–621-68-375). CFSTI.

A global measurement of the diurnal and seasonal variations of the primary atmospheric ions in the topside ionosphere between 280 and 2700 km was made using the ion mass spectrometer on Explorer 32. Evidence of direct correlation between solar zenith angle and the low and midlatitude distributions of thermal H^+, He^+, N^+, and O^+ was obtained as the satellite orbit plane traversed one complete diurnal cycle between June 11 and October 5, 1966. The northern midlatitude ionosphere at 1600 km, near the O^+–H^+ transition level, exhibited strong diurnal variation, O^+ rising sharply at dawn to become the dominant daytime ion with a concentration of 1×10^4 ions/cm^3, H^+ was dominant at night with a concentration of 1×10^4 ions/cm^3, a factor of five higher than its daytime value. The diurnal variations of N^+ and He^+ in this region resembled those of O^+ and H^+, respectively, at reduced concentrations. Measurements at 1200 km in the geomagnetic latitude intervals 45° to 55° (summer hemisphere) and −45° to −55° (winter hemisphere) showed a strong seasonal change in the O^+ and N^+ diurnal distributions, but little change in H^+ and He^+. (auth) (STAR)

27451 (N–69-18106) SUPRATHERMAL ELECTRONS IN THE POLAR IONOSPHERE. Maier, E. J. R. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Dec. 1968. 13p. (NASA-CR–63445; X–615-68-489). CFSTI.

A retarding-potential analyzer onboard Explorer 31 was used to observe energy distributions of suprathermal (5 E 200 eV) electrons in the polar ionosphere. Analysis of obtained electron flux data found a rapid decrease of the thermal particle Maxwell–Boltzmann distribution function in the region of interest. (STAR)

27452 (N–69-18839) TRIGGERING AN AURORA. Linson, L. M.; Petschek, H. E. (Avco-Everett Research Lab., Everett, Mass.). Apr. 1968. Contract NASw-1400. 47p. (NASA-CR–100158; AERL-RR-287). CFSTI.

The suggestion is made that the creation of a significant enhancement of the ambient electron density at night in the lower ionosphere at auroral latitudes may trigger an aurora. The resulting increased drag affecting a sufficient number of magnetic flux tubes will disturb the natural convective flow in the equatorial plane of the magnetosphere around L = 6. Criteria which indicate the required size of the electron cloud ($\approx 10^3$ km^3), its density ($\approx 10^6$ electrons cm^{-3}), and its location ($\approx$115 km altitude) are discussed. Such a large electron cloud is also useful for studies of the physics of the ionosphere. The necessary energy requirement and a preliminary evaluation of several methods which might be used to produce the desired ionization are discussed. (auth) (STAR)

27453 (N–69-19131) LABORATORY SIMULATION OF SOLAR WIND–EARTH INTERACTION. Chubb, Donald L. (National

Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Feb. 1969. 12p. (NASA-TM-X-1738). CFSTI.

A laboratory simulation experiment of the interaction of the solar wind and the Earth's magnetic field is being conducted. The plasma flow is produced by an MPD arc and a magnetic dipole is used to simulate the Earth's magnetic field. The initial investigations of the stagnation region of the flow show a rapid rise in the plasma potential. The magnetic field in this region is also altered from the dipole type behavior it exhibits when no flow exists. This region of change in plasma potential and magnetic field has a thickness characterized by the electron cyclotron radius. It appears to be a merging together of a collisionless deceleration and stagnation of the flow. However, whether or not a collisionless shock wave exists has not been conclusively demonstrated. (auth) (STAR)

27454 (N-69-19179) SPATIAL VARIATIONS OF THE MAGNETOSHEATH MAGNETIC FIELD. Behannon, Kenneth W.; Fairfield, Donald H. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Feb. 1969. 34p. (NASA-TM-X-63471; X-616-69-61). CFSTI.

Measurements by Explorers 28, 33, 34, and 35 were used to study the spatial characteristics of the magnetic field in the magnetosheath to a distance of 70 R_E behind Earth. Results indicate that the magnetosheath field is several times the strength of the simultaneously measured interplanetary field in the sunward magnetosheath. This magnetosheath to interplanetary magnitude ratio decreases with distance from the subsolar point to values which are frequently less than unity at distances beyond 30 R_E and away from the bow shock. This ratio also displays a dawn–dusk asymmetry which is dependent on the interplanetary field orientation. Interplanetary field lines perpendicular to the Earth–Sun line are associated with symmetrically distorted magnetosheath field lines in the dawn and dusk hemispheres and are consistent with the draping of field lines around the magnetosheath. When the interplanetary field is aligned near the spiral angle, fields measured in the dusk hemisphere are much more ordered than those measured in the dawn hemisphere behind the Earth. (auth) (STAR)

27455 (N-69-19180) SOME WINTER CHARACTERISTICS OF THE NORTHERN HIGH-LATITUDE IONOSPHERE. Miller, N. J.; Brace, L. H. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Dec. 1968. 27p. (NASA-TM-X-63468; X-621-68-495). CFSTI.

Langmuir-probe measurements of the winter diurnal behavior of the electron density (N_e) and temperature (T_e) at 1000 km at high latitudes are presented. The data are represented by contour plots of N_e and T_e on a grid of geomagnetic latitude and local time. The N_e distribution is characterized by a zonal structure where the auroral oval is the transition region between the midlatitude and polar zones. N_e in the midlatitude zone exhibits a quasi-steady state through most of the night and both N_e and T_e increase in value to an afternoon maximum. N_e in the dark polar zone decays until midnight after which the ionization increases toward a daytime level. The transition region, represented by the oval, shows enhancements in N_e suggestive of particle flux sources. In general, the dayside T_e contours do not correlate with the N_e contours. Limited comparisons between winter and summer indicate strong seasonal effects in the N_e pattern unusually large values of T_e in the winter midlatitude zone. Characteristic troughs in N_e appear on the nightside for both seasons. Possible ionization sources which would be consistent with the observed ionization patterns are considered. (auth) (STAR)

27456 COSMIC-RAY INFLUENCE ON THE HIGH-LATITUDE IONOSPHERE. Velinov, Pet'r. Izv. Geofiz. Inst., Bulg. Akad. Nauk, 13: 99-126(1968). (In Russian).

The electron production rate in the ionosphere at a consequence of the primary cosmic radiation and solar cosmic radiation is considered. (W.D.M.)

27457 AURORAL SPECTRA. Monfils, A. (Institut d'Astrophysique, Cointe-Sclessin, Belg.). Space Sci. Rev., 8: 804-45(Dec. 1968). (In French).

A review is presented of the main spectroscopic studies of polar aurora accomplished during the past eight years. The few new results concerning knowledge of the spectrum itself are examined. The various kinds of auroral phenomena are classified with respect to altitude and latitude. The influence of two important parameters, time and location, is examined as a possible means of detection of different mechanisms. The latest developments of experimental methods are discussed. (W.D.M.)

27458 ION KINETICS OF THE LOWER IONOSPHERE. Nestorov, Georgi. Izv. Geofiz. Inst., Bulg. Akad. Nauk, 13: 5-36(1968). (In Russian).

The basic physico-chemical reactions leading to ionization of the neutral gas in the upper atmosphere (below 100 km) are considered: ionization from electromagnetic and particle radiation, charge transfer, and ion–atomic interchange. (W.D.M.)

27459 THE MIDDLE AND UPPER IONOSPHERE DURING THE SOLAR ECLIPSE OF MAY 20, 1966. Serafimov, Kiril. Izv. Geofiz. Inst., Bulg. Akad. Nauk, 13: 37-64(1968). (In Russian).

The effects of the solar eclipse of May 20, 1966, on the E, E2, F1, and F2 layers of the ionosphere were studied. Fine structure and electron production rates were determined for the individual layers. (W.D.M.)

27460 IONO-INDEX ABOUT THE HARD EMISSION OF THE SOLAR-ACTIVE REGIONS. Nestorov, G. (Geophysical Inst., Sofia); Letfus, V. J. Atmos. Terrest. Phys., 31: 571-8(Apr. 1969).

The fluctuations of field strength of the radiowave propagation with an equivalent frequency of about 25 kHz are analyzed for the period 1964–1967. Under daytime conditions it appears that by means of a suitable numerical estimation of these fluctuations, taking into consideration their dispersion from the middle field strength during the day, their number and also the field deviation from the standard curve for a given season and phase of the solar activity, it is possible to introduce an index b_1^2 which correlates with the sunspot relative number R at low and moderate solar activity. The b_1^2 index takes into account the field strength disturbance due to the long and slowly varying background hard x radiation. A second index b_2 takes into account the number, amplitude and duration of SID effects in the D region. (auth) (UK)

27461 INCLUSION OF A PARTICLE SOURCE OF IONIZATION IN THE IONOSPHERIC CONTINUITY EQUATION. Torr, M. R.; Torr, D. G. (National Inst. for Telecommunications Research, Johannesburg). J. Atmos. Terrest. Phys., 31: 611-14 (Apr. 1969).

A production source of ionization due to low-energy electron influx is included in the ionospheric continuity equation. The steady-state nonlinear, second-order, differential equation is solved for a midlatitude station, Johannesburg (26°S, 28°E), for a period of low solar activity. It is shown that ionization by particles could be a major factor in explaining the quiet ionosphere. (auth) (UK)

27462 SHORT-PERIOD PHASE-HEIGHT OSCILLATIONS IN THE E REGION. Vincent, R. A. (Univ. of Saskatchewan, Saskatoon, Can.). J. Atmos. Terrest. Phys., 31: 607-9(Apr. 1969).

Phase-height measurements of the E region using pulsed radio waves are presented, showing short-period fluctuations. The minimum time scale of the variations was about five minutes. It is suggested that these fluctuations are caused by small-scale gravity waves. (auth) (UK)

27463 ATOMIC NITROGEN ION DISTRIBUTION AND λ 5755 EMISSION IN THE AURORAL IONOSPHERE. Brown, R. R. (Univ. of California, Berkeley). J. Atmos. Terrest. Phys., 31: 601-6 (Apr. 1969).

Calculations are presented to show the nighttime distribution of N^+ with the incidence of an aurora. Use is made of the λ3914/5755 intensity ratio to estimate the fraction of dissociative ionization encounters of electrons with N_2 which lead to the metastable ^1S state of N II. (auth) (UK)

27464 RELATIONSHIP BETWEEN AURORAL-ZONE X-RAY PULSATIONS AND DEVELOPMENT OF THE AURORAL ELECTROJET. Kangas, J. (Laboratoire de Physique Cosmique, Meudon, France); Tanskanen, P. J. J. Atmos. Terrest. Phys., 31: 597-600(Apr. 1969).

Observations are presented of pulsation-like variations of auroral-zone x-ray intensity during a large geomagnetic disturbance. Slow pulsations were observed when the auroral electrojet was developing to its maximum phase. It is shown that these pulsations may be produced by the atmospheric feedback modulation suggested by Maehlum and O'Brien (1968). (auth) (UK)

27465 ANALYSIS OF IONOSPHERIC DRIFT DATA IN THE CLOSELY SPACED RECEIVER METHOD. Beynon, W. J. G.; Wright, J. C. (University Coll. of Wales, Aberystwyth). J. Atmos. Terrest. Phys., 31: 593-6(Apr. 1969).

Data are presented which show that in many cases the orientation of the correlation ellipse shows a degree of dependence on the relative disposition of the three receiving aerials. It is suggested that this phenomenon is to be expected when the extremal lines of the diffraction pattern are curved rather than straight. (auth) (UK)

27466 SECOND EXPERIMENT ON INVESTIGATION ION-MOLECULAR REACTION CONSTANTS DIRECTLY IN THE

IONOSPHERE. Danilov, A. D.; Semenov, V. K. (Inst. of Applied Geophysics, Moscow). Dokl. Akad. Nauk SSSR, 183: 326-8(Nov. 11, 1968). (In Russian).

The following ion-molecular reactions play an important role in ionization–recombination processes in the Earth's ionosphere: 1) $O^+ + N_2 \rightarrow NO_2^+ + N$, and 2) $O^+ + O_2 \rightarrow O_2^+ + O$. Laboratory meaasurements show a significant deviation in values of the reaction constants. Mass-spectrometric measurements during rocket flight at a height of 400 km gave a value of $\gamma_2/\gamma_1 > 10$. The experiment was repeated in March, 1967. The mass 16 peak was assigned to the O^+ ion. The data showed that the value of γ_2/γ_1 was between 10 and 15 at a height of 170 km. These data are useful in understanding how trustworthy the laboratory data may be. (TTT)

27467 THE VALIDITY OF THE "OVERLAY" TECHNIQUE FOR ANALYZING THE F1–F2 TRANSITION. King, G. A. M. J. Atmos. Terrest. Phys., 31: 515-29(Apr. 1969).

The "overlay" technique depends on the idea that the shape around F1 on an ionogram can be expressed quantitatively. By use of a new very flexible set of overlays this idea was tested and found adequate. Other concepts needed for interpreting the results of the analysis, such as the equivalent scale height for electron production, are explored. (auth) (UK)

27468 ON THE HIGH-LATITUDE, UNIVERSAL-TIME-CONTROLLED F LAYER. Maehlum, Bernt N. (Rice Univ., Houston, Tex.). J. Atmos. Terrest. Phys., 31: 531-8(Apr. 1969).

The critical frequency of the ionospheric F2 layer and the low-energy electron precipitation in the polar-cap regions show similar temporal and spatial characteristics, indicating that the polar F2 layer is at least partly maintained by energetic particle ionization. (auth) (UK)

27469 ACOUSTIC WAVES IN THE IONOSPHERE. Rao, N. Narayana (Univ. of Illinois, Urbana); Lyon, G. F.; Klobuchar, John A. J. Atmos. Terrest. Phys., 31: 539-45(Apr. 1969).

An unusual traveling ionospheric disturbance was detected from Faraday-rotation observations of 40- and 41-MHz signals from the radio beacon satellite BE-B, inclination 80°, observed simultaneously at Urbana, Illinois (40.1°N, 88.2°W), Danville, Illinois (40.1°N, 87.6°W), London, Ontario (43.0°N, 81.3°W), and Hamilton, Massachusetts (42.6°N, 70.8°W) three of which are widely spaced. The fluctuations in the total electron content deduced from these observations are interpreted as a superposition of long—about 3.5 min—and short period—about 15 to 50 sec—acoustic waves. The magnitudes obtained for horizontal velocities of propagation averaged about 4.5 km/sec at 350-km height and indicate wavefront tilts averaging about 10° from the horizontal if the waves are assumed to travel at the speed of sound at 200 km height. (auth) (UK)

27470 OBSERVATIONS OF M ARC AT MOSCOW, Idaho, U.S.A. Ichikawa, T. (Univ. of Idaho, Moscow); Kim, J. S. J. Atmos. Terrest. Phys., 31: 547-53(Apr. 1969).

A multicolor airglow photometer was operated at Moscow Mountain, Idaho (latitude: 46°50′N.; longitude: 116°58′W.), during 56 nights between June and November, 1967. A weak but well-defined M arc was observed on the night of September 28/29, 1967, when there were high geomagnetic and visible auroral activities. The M arc occurred between L = 2.6 and L = 3.4, assuming a dipole field. The peak intensity remained fairly constant throughout the night. The average peak intensity was 220R, which is only 1/20 of the corresponding value obtained at Fritz Peak, Colorado on September 29/30, 1957. The extreme and half-intensity widths at 20.33 hr P.S.T. were 700 and 210 km, respectively. The arc moved southward during the night with an average speed of 32 m/sec. (auth) (UK)

27471 MEASUREMENTS OF IONOSPHERIC ELECTRON CONTENT OVER KHARTOUM. Jayendran, A.; O'Brien, P. A. (Univ. of Khartoum, Sudan). J. Atmos. Terrest. Phys., 31: 555-62(Apr. 1969).

The columnar electron content, N_T, was measured at Khartoum using the 40-Mc transmission from the satellite S-66 for a period of just over a year in 1964–65. The diurnal variation of N_T showed a maximum several hours after noon, with a tendency for this maximum to be double-peaked. During the night N_T decayed, with an effective loss coefficient β' which was approximately constant, except for a period of several hours, varying with season, during which N_T remained steady or, in summer, had a secondary maximum. It is suggested that this behavior may be due to transport of ionization along magnetic field lines away from the magnetic equator. (auth) (UK)

27472 SOLAR ABSORPTION PHOTOMETRY AND THE DETERMINATION OF ATMOSPHERIC COMPOSITION. Carver, J. H. (Univ. of Adelaide); Edwards, P. J.; Gough, P. L.; Gregory, A. G.; Rofe, Bryan; Johnson, S. G. J. Atmos. Terrest. Phys., 31: 563-70(Apr. 1969).

Molecular oxygen and total number densities in the altitude range 70 to 120 km were determined at Woomera by rocket measurements of the atmospheric absorption of solar ultraviolet and x radiation using nondispersive detectors carried in a Long Tom rocket fired to coincide with a pass over Australia of Explorer 30. Comparison of the measured total and molecular oxygen number densities indicated a significant change in atmospheric composition above 100 km. Absolute measurements of the solar flux for several wavelength bands within the range 1050 to 1680 Å were obtained and are compared with Explorer 30 values. (auth) (UK)

27473 MODULATION OF AURORAL ELECTRONS AT LARGE DISTANCES FROM THE EARTH. Bryant, D. A.; Courtier, G. M.; Johnstone, A. D. (Radio and Space Research Station, Slough, Eng.). J. Atmos. Terrest. Phys., 31: 579-92(Apr. 1969).

The intensities of auroral electrons with energies of 10, 4, and >2 keV were measured from a rocket launched into a post-breakup aurora from Andøya in Northern Norway. Changes of intensity with periods greater than one second were found to occur earlier at 10 keV than at the other energies; the average delay between 10- and 4-keV electrons was 0.45 ± 0.1 sec and the average delay between 10- and >2-keV electrons was 0.18 ± 0.06 sec. The delays are interpreted as dispersion effects following modulation at or near the geomagnetic equator on the L = 6 magnetic shell. (auth) (UK)

27474 ATMOSPHERIC VERTICAL ENERGY FLUX DUE TO A GROUND DISTURBANCE. MacKinnon, Robert F. (Imperial Coll. of Science and Tech., London). Can. J. Phys., 47: 707-25(Apr. 1, 1969).

Evaluations are given of the net mean vertical energy flux due to small oscillations at several altitudes caused by a ground disturbance in a wind- and temperature-stratified atmosphere. A theoretical model is assumed which consists of an inviscid perfect gas above a flat nonrotating Earth. Results are given for various wind and temperature profiles. It is found that winds can appreciably affect the energy flux due to long-period waves at great heights. The importance of the temperature structure in the vicinity of critical levels is demonstrated. The significance of "leaky" modes is discussed with regard to the relationship between the discrete and continuous spectra of waves. A simple approximation to energy flux associated with acoustic waves of short periods is found to apply for certain ground disturbances. The relevance of the results to traveling ionospheric disturbances is discussed. (auth)

27475 RECENT OBSERVATIONS OF THE AURORAL SPECTRUM BETWEEN 1.02 AND 1.13 μ. Harrison, A. W. (Univ. of Calgary, Alberta). Can. J. Phys., 47: 599-606(Mar. 15, 1969).

During the summer of 1968, observations were made of the auroral spectrum at 27 Å spectral resolution between 1.02 μ and 1.13 μ. Absolute brightnesses were estimated from the spectra for the N_2^+ Meinel (0–0) band, N_2 1PG (0–0) band and $^2D^0 - {}^2P^0$ (N I) line after subtraction of the background night airglow spectrum and after correcting for atmospheric extinction. Simultaneous measurements of the N_2^+ 1NG (0–0) band and O I line at 5577 Å have facilitated the reduction of the infrared brightnesses to the equivalent international brightness coefficient III brightnesses. (auth)

27476 Sq CURRENTS IN A THREE-DIMENSIONAL IONOSPHERE. Cocks, A. C.; Price, A. T. (Univ. of Exeter, Eng.). Planet. Space Sci., 17: 471-82(Mar. 1969).

Calculations were made of Sq currents on the assumption that they are caused by electromotive forces produced by tidal winds at the base of an ionosphere that extends upwards to considerable heights, and has some of the features of the conductivity distribution of the actual ionosphere. It is shown that the current flow is nearly horizontal throughout the region of importance and that the "layer equations" are therefore approximately true. The strictly horizontal part of the current flow is not, however, nondivergent and it is not possible to define a current function for it. The calculated currents are divided into two parts, one of which has a field below the ionosphere, while the other does not. The significance of this is considered in relation to the interpretation of analyses of observations of Sq variations. (auth) (UK)

27477 MORPHOLOGY OF THE SOUTHERN RADIO AURORAL ZONE. Shipstone, D. M. (Univ. of Sheffield, Eng.). Planet. Space Sci., 17: 403-20(Mar. 1969).

Observations of the radio aurora were made from Halley Bay, British Antarctic Territory, during the IQSY using a system of three rhombic aerials at a frequency of 71.3 MHz. The geometry of the echo region observable from Halley Bay is such that, with the aerial system used, radio aurora could be observed frequently over the range of geomagnetic latitudes 67 to 71.5°S. Diffuse and discrete echoes were distinguished in the analysis of the film records, and the distributions of these types of radio aurora over the above latitude range were deduced as functions of universal time and K_p. The two types of radio aurora were found to occupy different zones, which overlap close to the midnight meridian. Further evidence is presented which suggests that these zones are "ovals," which also overlap near the noon meridian. These zones are compared with the spiral patterns which have been deduced for several other upper atmospheric phenomena. It is suggested that the diffuse and discrete radio auroras may be associated with proton and electron precipitation, respectively, and that charge separation in the magnetosphere may produce the observed zone pattern. (auth) (UK)

27478 PRELIMINARY COMPARISON OF SOLAR WIND PLASMA OBSERVATIONS IN THE GEOMAGNETOSPHERIC WAKE AT 1000 AND 500 EARTH RADII. **Intriligator, Devrie S.; Wolfe, John H.; McKibbin, Darrell D.; Collard, Harold R. (Ames Research Center, Moffett Field, Calif.). Planet. Space Sci., 17: 321-32(Mar. 1969).**

Preliminary comparison of observations in the expected region of the geomagnetic tail 1000 R_E with (Pioneer 7, September 1966) and 500 R_E (Pioneer 8, January 1968) indicates that the measured plasma characteristics in these regions are similar. In each case intervals of quiescent plasma ion energy spectra are interrupted by abrupt changes in the magnitude and shape of the ion spectra or by complete absence of measurable plasma. Each of these regions is highly disturbed and is most appropriately described by the term "geomagnetospheric wake." A comparison with measurements in the near-Earth region of the geomagnetic tail indicates that the characteristics of the geomagnetic tail apparently undergo significant changes between 80 and 500 R_E. (auth) (UK)

27479 BOUNCE-RESONANT INTERACTION BETWEEN PULSATIONS AND TRAPPED PARTICLES. **Southwood, D. J.; Dungey, J. W.; Etherington, R. J. (Imperial Coll. of Science and Tech., London). Planet. Space Sci., 17: 349-62(Mar. 1969).**

The exchange of energy between a given wave and the energetic particle population is investigated, with emphasis on waves with a rapid east–west variation of phase. Reasons are given why these are of particular interest. The field disturbance has yet to be computed in detail, but a physical account is presented leading to rough estimates for the damping or amplification. The techniques applied to gyroresonance are followed as closely as possible, but bounce resonance is more complicated, and great simplifications are made, particularly in neglecting harmonics. Transformation to the rotating frame of the wave gives a simple way of calculating the change in energy of a single particle for a given change in L. The resonance condition including the Doppler shift due to the east–west particle drift, is a quadratic for the particle energy. Typically there is a low energy for which the bounce frequency almost equals the wave frequency and a high energy for which the Doppler-shifted frequency is much higher than the wave frequency. The high-energy resonance is more favourable for wave amplification by the kind of particle distribution known to exist. Typically, the high-energy electrons are relativistic, and attention is given to the high-energy proton resonance. For westward-traveling waves, protons that move out lose energy and the outer edge of a proton belt could supply energy to such a wave via bounce resonance. Calculations are based on the strongest known mechanism. This requires a disturbance in B_r at the equator, which has been observed by Coleman. Because of ignorance of the wave fields it was found convenient to use quasilinear theory rather than linear theory in estimating the damping or growth rate. The resulting expressions for the exchange in energy are easier to interpret physically. The results show that the damping is quite powerful, and the conditions required for amplification are discussed. It is pointed out that the east–west component of the group velocity of such waves is small and this may be important in applications to the magnetosphere. (auth) (UK)

27480 SATELLITE EVIDENCE FOR THE GENERATION OF VLF EMISSIONS AT MEDIUM LATITUDE BY THE TRANSVERSE RESONANCE INSTABILITY. **Bullough, K.; Hughes, A. R. W.; Kaiser, T. R. (Univ. of Sheffield, Eng.). Planet. Space Sci., 17: 363-74(Mar. 1969).**

During the great magnetic storm of May 25/26, 1967, the orbital plane of the Ariel III satellite (altitude 500 to 600 km, orbital inclination 80°) lay in the dawn/dusk sector of the magnetosphere. By means of the on-board tape recorder it was possible to determine in some detail the storm-time evolution of the vlf activity both in intensity and distribution (in invariant latitude). The results are interpreted in terms of generation by the transverse resonance plasma instability. It is shown that the emissions are generated in the vicinity of the geomagnetic equator and exhibit a maximum or saturation intensity close to that predicted by Kennel and Petschek (1966). The maximum intensity of the zone occurs on an L-shell where the minimum gyrofrequency (at the geomagnetic equator) is somewhat greater than the frequency of observation. In the morning sector the vlf emissions stay near to the saturation intensity throughout the solar-wind enhancement; in the evening sector they attain saturation intensity towards the end of the storm, during the deflation of the magnetosphere and the decay of the asymmetric ring current. (auth) (UK)

27481 A SELF-CONSISTENT RING CURRENT IN THE EARTH'S DIPOLE FIELD. **Sozou, C.; Windle, D. W. (Univ. of Sheffield, Eng.). Planet. Space Sci., 17: 375-88(Mar. 1969).**

A self-consistent, time independent, ring current model of a charged particle distribution under the influence of the combined field of the Earth's dipole and the field due to the currents of the particle motions is constructed. The method of solution consists of successive iterations of the magnetic field of the currents due to the particle motions in the combined field until this field converges to its limit. The results are compared with computations of similar particle distributions moving in the Earth's dipole field alone, and conclusions are drawn regarding the accuracy of computations that ignore the self effect of the ring current. (auth) (UK)

27482 RADIO-FREQUENCY SYNCHROTRON RADIATION FROM TRAPPED ELECTRONS ABOVE THE AURORAL ZONES. **Vesecky, John F. (Univ. of Leicester, Eng.). Planet. Space Sci., 17: 389-402(Mar. 1969).**

Electrons from the outer Van Allen Belt emit synchrotron radiation most strongly in the radio-frequency range from 5 to 20 MHz when substantial electron fluxes enter the relatively strong geomagnetic fields above the auroral zones, i.e., $B \approx 0.15$ G and $L \approx 4.5$. Estimates made on the basis of average electron fluxes indicate that the brightness observed by a high-altitude Earth satellite would be comparable only with the dimmest portion of the galactic radio background. However, the electron flux in this region is highly variable and at times the observed brightness will appear a great deal brighter than average. Discrimination between synchrotron radiation and the cosmic background on the basis of polarization is shown to be an applicable technique. (auth) (UK)

27483 THE TRANS-POLAR EXOSPHERIC PLASMA. III. A UNIFIED PICTURE. **Thomas, J. O.; Andrews, M. K. (Imperial Coll. of Science and Tech., London). Planet. Space Sci., 17: 433-46(Mar. 1969).**

The results of recent work on the spatial distribution of the trans-polar exospheric electron density, using data from the Alouette I satellite together with recent low energy electron flux measurements in the polar regions provide a unified picture of the polar plasma. The three main features of the unified model are discussed. The first is the identification and location of a plasma ring surrounding each pole, stationary with respect to the Sun, and under which the Earth rotates. The second relates to geomagnetic control of the ionization, with the recognition of paramount effects occurring at certain universal times associated with the geometry of the geomagnetic axis— Earth–Sun line system. The third relates to the termination of the terrestrial plasmasphere. (auth) (UK)

27484 THE PLASMAPAUSE, THE PLASMA SHEET, AND ENERGETIC TRAPPED ELECTRONS IN THE EARTH'S MAGNETOSPHERE. **Rothwell, P.; Lynam, C. (Univ. of Southampton, Eng.). Planet. Space Sci., 17: 447-54(Mar. 1969).**

Observations from the IMP 2 satellite show that much of the energetic trapped radiation observed near the equatorial plane lay beyond the plasmapause, which therefore cannot be the boundary between "open" and "closed" field lines in the Earth's magnetosphere. The position of peak intensity for electrons >45 keV generally lay just beyond the plasmapause, while the position of peak intensity for electrons >1.6 MeV lay just inside it. The "slot," the position of minimum intensity between inner and outer radiation belts, lay well inside the plasmapause for both 1.6-MeV and 45-keV electrons. The boundary between the stable trapping zone and the "distant" radiation zone of highly fluctuating particle fluxes, which also lay beyond the plasmapause, near 10 R_E during quiet times, moved as close to the Earth as 6 R_E shortly after onset of magnetic bays; these positions are close to those reported for the inner boundary of the plasma sheet. It is suggested that: (1) The plasmapause is the limiting magnetic shell at which most terrestrial plasma of ionospheric origin can remain trapped, if there is an electric field across the magnetosphere. (2) The inner boundary of the plasma sheet is the limiting distance to which the more energetic interplanetary plasma can penetrate into the Earth's field under the action of the same magnetospheric electric field. (auth) (UK)

27485 STRUCTURE OF THE MAGNETOPAUSE. Davies, Christine M. (Queen Mary Coll., London). Planet. Space Sci., 17: 333-8(Mar. 1969).

Previous work on the structure of the boundary layer between a cold plasma and a vacuum magnetic field is extended to include the effect of a transverse velocity component perpendicular to the applied field. The exact equations of the problem, taking into account the electrostatic field arising from charge separation in the boundary, are solved numerically. It is shown that the effect of this velocity component is negligible unless the boundary layers are almost completely neutralised by the presence of a background plasma. If neutralisation is complete, the transverse velocity component is responsible for an inversion of the magnetic field direction across the boundary. (auth) (UK)

27486 THE INFLUX OF CHARGED PARTICLES AT THE MAGNETIC CUSPS ON THE BOUNDARY OF THE MAGNETOSPHERE. Willis, D. M. (Radio and Space Research Station, Slough, Eng.). Planet. Space Sci., 17: 339-48(Mar. 1969).

The influx of charged particles from the postulated cusp-shaped regions of stagnant plasma trapped in the vicinity of the two magnetic cusps (which were treated as true neutral points in the earlier studies) on the polar magnetopause is re-examined. It is argued that the discharge of the polarization electric field at the magnetopause through the magnetosphere–ionosphere circuit under steady-state conditions leads to an increase in the influx of particles. Moreover, once the electrostatic field is completely discharged, the maximum influx from each cusped containment region can be calculated analytically from a steady-state statistical model, without restrictive assumptions regarding the form of the equilibrium configuration. It is found that the influx of protons from each cusp is about 5×10^{24} per sec for representative solar-wind parameters. This provides a maximum influx of energy from each cusp of about 10^{15} ergs per sec. (auth) (UK)

27487 ELECTROMAGNETIC INDUCTION IN THE EARTH BY THE EQUATORIAL ELECTROJET. Hutton, R. (Univ. of Ibadan, Nigeria). Nature (London), 222: 363-4(Apr. 26, 1969).

Reference is made to Price's theory (J. Geophys. Res. 67: 1907(1962)) regarding the relationship between components of the Earth's magnetic field and components of the currents induced by this varying magnetic field in the Earth's surface ("Earth currents"). This theory is applicable to induction problems in the equatorial electrojet region, since it covers the case where there are appreciable space gradients in the inducing field. It is stated that in the region of the magnetic-dip equator it is possible to deduce relatively simple expressions relating the magnetic field components and those of the induced Earth currents if some assumptions are made concerning the nature of the equatorial electrojet current systems. These assumptions are discussed. An investigation is in progress to apply the derived expressions to observations in the equatorial region, and some of the implications are discussed. The theory is being applied to observational data from Nigeria, with the object of estimating values of electrical conductivity in the Earth's crust and mantle. (UK)

27488 RADIAL VELOCITY AND INTENSITY MEASUREMENTS OF THE NIGHT-SKY Hβ EMISSION LINE. Reay, N. K.; Ring, J. (Imperial Coll. of Science and Tech., London). Planet. Space Sci., 17: 561-74(Mar. 1969).

Observations of the Hβ emission line in the night-sky spectrum are presented. The measurements were made with a gas pressure-scanned Fabry–Perot Interferometer from Testa Grigia (11,500 ft) in the Italian Alps, in November and December, 1967. Typical emission rates measured were 0.1 to 0.2 Rayleighs (R), and the line was found to be Doppler-shifted from the 4861.33 Å laboratory wavelength. The intensities and radial velocities of the line are examined in various co-ordinate systems and it is shown that the total emission is probably due to the addition of two components; a "galactic" and a "nongalactic" contribution. The galactic contribution, due to nebular emission, dominates within ±15° latitude of the Milky Way; the emission at galactic latitudes greater than ±15° is interpreted as being nongalactic in origin and is discussed briefly in terms of both geocoronal and interplanetary emitting regions. (auth) (UK)

27489 AMBIPOLAR DIFFUSION AND MOTION OF ION CLOUDS IN THE EARTH'S MAGNETIC FIELD. Kaiser, T. R.; Pickering, W. M.; Watkins, C. D. (Univ. of Sheffield, Eng.). Planet. Space Sci., 17: 519-52(Mar. 1969).

It is shown that the behavior of an ion cloud at altitudes above about 95 km may depend strongly on its initial configuration, and particularly whether it is closely magnetic-field aligned. From consideration of planar ionized irregularities it is found that diffusion across the field lines is ion-controlled unless the irregularities are closely field aligned (to within 1° in the E region, and less in the F region). In the latter case the transverse diffusion is electron controlled (above 95 km) and hence considerably inhibited by the magnetic field. This result is also confirmed by numerical computations for the case of cylindrical irregularities. Somewhat similar results are found for the effects of neutral winds and electric fields. For instance, it is shown that, in the E region, ion clouds will move with the neutral wind unless they are highly field-aligned, when they will remain fixed to the magnetic field lines. An electric field E, at right angles to the magnetic field B, causes an irregularity to move in the direction of $E \wedge B$; non field-aligned irregularities move with the Hall drift velocity of the ions, while field-aligned irregularities move with the Hall drift of the electrons. These velocities are approximately equal in the F region, but differ greatly in the E region This is proposed as the explanation for the large east–west motions ($\sim$1 km sec^{-1}) of field-aligned irregularities observed in the radio-aurora, and requires a meridional electric field of order 50 mV/m. Observations of radio meteor trains, made at a frequency of 501 MHz, are described. These reveal a significant effect of the geomagnetic field at altitudes above 92 km, both on the rate and duration of the echoes, when the aerial beam makes a normal intersection with the magnetic field lines at these altitudes. The experimental results are compared with the theoretical predictions for diffusion in the geomagnetic field. (auth) (UK)

27490 HYDROMAGNETIC WAVES AND THE LOWER IONOSPHERE. Lawrie, J. A. (Univ. of Sussex, Brighton, Eng.). Planet. Space Sci., 17: 509-18(Mar. 1969).

Nonuniform two-dimensional hydromagnetic waves are assumed to be incident on an idealised lower ionosphere. The waves have a sinusoidal horizontal amplitude factor. The ionosphere and sea-level region is represented by a simple layered model. The ionospheric Pederson conductivity is made zero and the Earth's magnetic field vertical. Transmission and reflection are examined theoretically, and the following results are noted: (1) At sea level, resonant peaks in amplitude occur at about the same periods as for incident plane waves; but the longest period peak is absent. (2) Polarisation at sea level is linear. (3) Reflection from the lower ionosphere is imperfect. (4) A modified plane wave model is valid at short periods. (5) The thin ionosphere model is valid at long periods. (auth) (UK)

27491 AUTOMATIC EVALUATION OF IONOSPHERIC CURRENT SYSTEMS. Stone, D. J. (Univ. of Exeter, Eng.). Planet. Space Sci., 17: 491-6(Mar. 1969).

The world-wide analysis of the mean hourly values of the field components determined at magnetic observatories into constituent fields and associated ionospheric current systems involves a considerable amount of computation. It is therefore necessary to design and implement a computer program to carry out the complete analysis. The design features of the program, and the necessary sequence of steps required for the automatic evaluation, are described. The general physical and numerical problems involved are discussed, with particular reference to the determination of field values which satisfy a potential, and a method of solution is presented. (auth) (UK)

27492 SOLAR X-RAYS AND THE IONOSPHERE. Boyd, R. L. F. (University Coll., London). Endeavour, 28: 82-5 (May 1969).

A review is presented of recent advances in the knowledge of the penetration of the atmosphere by both x rays and ultraviolet radiation, and their photochemical and electrochemical effects on its composition. (auth) (UK)

27493 NIGHT AIRGLOW O I GREEN, CONTINUUM, AND HYDROXYL EMISSIONS. Waddoups, Ray Owen. Logan, Utah, Utah State Univ., 1968. 109p.

Thesis.

Three rocketborne measurements of night airglow emissions are reported. Maximum O I green emission of 14 R/km was observed at 102 km. Maximum continuum emission of 0.04 RA^{-1} km^{-1} was observed at 91 km, and maximum OH (8,3) emission of 44 R/km was observed at 97 km. Simultaneous measurement of high-energy electron flux and O I green emission showed that no significant amount of excitation resulted from high-energy electron bombardment. These emission measurements, together with similar measurements reported by other investigators, were analyzed to determine the excitation mechanisms responsible for the emissions. The shapes of the observed emission-versus-altitude profiles indicated that the Chapman mechanism is the source of oxygen green emission. The observed emission rates also agreed with the theoretical rate for the Chapman mechanism. Seasonal fluctuations in altitude were observed and were recommended for additional study along with seasonal variations in emission rate. Continuum emission-versus-altitude profile shapes showed the NO + O reaction mechanism to be the likely source of the night airglow continuum. The observed emission rate was shown to agree with the theoretical rate. Hydroxyl emission was shown to fluctuate in a complicated manner. Quenching by ozone appeared to be the probable explanation for part of the differences between emission observations. Additional studies should reveal seasonal and diurnal patterns of change. (Disser. Abstr.)

27494 SEASONAL VARIATIONS OF ELECTRON DENSITIES BELOW 100 km AT MIDLATITUDES. I. DIFFERENTIAL ABSORPTION MEASUREMENTS. **Gregory, J. B.; Manson, A. H.** (Univ. of Saskatchewan, Saskatoon, Can.). J. Atmos. Terrest. Phys., 31: 683-701(May 1969).

The differential absorption experiment (D.A.E.) for measuring electron densities in the lower ionosphere, using partial reflections, is examined. A model of the scattering process which invokes sharply bounded horizontally stratified irregularities is found to be more satisfactory than one based on volume scattering. The ratio of calculated reflection coefficients for the two magnetoionic components, R_x/R_0, is found to be insensitive to the geometry of reflecting boundaries, and to the fractional changes in electron concentration, $\Delta N/N$, provided the refractive index n tends to unity; but it is affected by the propagation angle with respect to the magnetic field. The nature of irregularities in the lower ionosphere is discussed, and it is concluded that perturbations in collision frequency, $\Delta\nu/\nu$, are not significant for the calculation of R_x/R_0. Models of collision frequency profile, $\nu(h)$ for three seasons are derived from meteorological data. Differences in probable collision frequencies between northern and southern hemispheres are examined. The sensitivity of the method, to changes in assumed $\nu(h)$, is discussed. The capability of the D.A.E. to produce electron density profiles of good height resolution and accuracy is evaluated. Errors involved in the assumption of $\nu(h)$ and the measurement of the amplitude ratio of the received magneto-ionic components, A_x/A_0, are discussed. (auth) (UK)

27495 SEASONAL VARIATIONS OF ELECTRON DENSITIES BELOW 100 KM AT MIDLATITUDES. II. ELECTRON DENSITIES AND ATMOSPHERIC CIRCULATION. **Gregory, J. B.; Manson, A. H.** (Univ. of Saskatchewan, Saskatoon, Can.). J. Atmos. Terrest. Phys., 31: 703-20(May 1969).

A series of noon electron densities between 65 and 90 km were derived from measurements of differential absorption of partial reflections during 1963–1967 at Christchurch, N. Z., 44°S. From 312 profiles, mean profiles for the four seasons are assembled. The mean noon winter profile is adequately described by the empirical relation: $N = 65 \exp [(h-66)/16]/\text{cm}^3$, $66 < h < 88$ km. Mean noon electron densities between 79 and 88 km are larger in winter and spring than in summer, such that when corrected to equivalent overhead Sun conditions, the winter/summer ratio is 1.9 : 1. The corresponding ratio for Ottawa, 45°N, is 1.2 : 1. Only minor maxima and minima appear above 70 km. Limited evidence points to the existence of a maximum below 70 km. The electron densities are used to compute values of ionospheric absorption at 2.4 MHz up to 88 km. The seasonal variation of these values is similar to that observed in the northern hemisphere, and also to measured variations in the southern hemisphere, at all midlatitudes. The coefficients of variation (standard deviation/mean) of noon electron densities are computed, and also the ranges of monthly means for similar months in the 5 yr period. Systematic annual trends in both these quantities are found, particularly a steady increase of variability from fall to winter, and a marked decrease in summer. These characteristics, and the winter increase of electron densities, are considered as aspects of a dynamic atmosphere. Seasonal changes in the atmospheric circulation from 20 to 100 km are discussed and the characteristics of upward propagation of planetary and cyclonic waves in the troposphere and stratosphere through the mesosphere at different seasons are summarized. It is shown that the seasonal circulation changes and the perturbations produced by such waves can provide a qualitative explanation of the observed seasonal variability of electron densities. Effects of transport by such waves are examined in principle. A first comparison is made between seasonal variations of temperatures at 86 km, 44°S, derived from radiowave wind measurements, and of electron densities, 80 to 88 km. (auth) (UK)

27496 ION CHEMISTRY OF THE D- AND E-REGIONS: A SURVEY FOR WORKING GROUP 11 OF THE INTER-UNION COMMISSION ON SOLAR-TERRESTRIAL PHYSICS. **Bowhill, S. A.** (Univ. of Illinois, Urbana). J. Atmos. Terrest. Phys., 31: 731-42(May 1969).

In planning programs for study of the Earth's environment in the next few years the Inter-Union Commission on Solar–Terrestrial Physics (IUCSTP) has endorsed a project for the study of the ion chemistry of the D and E regions. This paper surveys the physical and chemical processes thought to be important, and makes recommendations for theoretical and experimental studies. (auth) (UK)

27497 COMPARISON OF RUSSIAN AND BRITISH ELECTRON DENSITY DISTRIBUTIONS DERIVED FROM THE SAME vlf AND lf PROPAGATION DATA. **Bain, W. C.** (Radio and Space Research Station, Ditton Park, Eng.). J. Atmos. Terrest. Phys., 31: 755-8(May 1969).

Russian and British workers have both used the same vlf and lf propagation data, mainly taken in England in the period 1947–51, to derive electron density distributions in the D region. The Russian curve of electron density resembles a smoothed version of the British curve. The reason for the marked maximum and minimum near 60 km in the British results is considered. (auth) (UK)

27498 LUNAR TIDAL OSCILLATIONS IN IONOSPHERIC ABSORPTION AT COLOMBO. **Rastogi, R. G.** (Physical Research Lab., Ahmedabad, India). J. Atmos. Terrest. Phys., 31: 759-61(May 1969).

A semi-monthly lunar variation in D-region absorption with an amplitude of about 0.38 dB, with the maximum of 3.3 hr lunar time, occurs at Colombo. There is evidence of phase reversal of lunar tides between the equatorial and high latitudes in the D-region absorption, similar to that in F2-region critical frequency. (auth) (UK)

27499 LUNAR VARIATION OF IONOSPHERIC ABSORPTION OF RADIO WAVES AT DIFFERENT FREQUENCIES. **Kotadia, K. M.; Patel, B. M.** (Gujarat Univ., Ahmedabad, India). J. Atmos. Terrest. Phys., 31: 621-30(May 1969).

Noon ionospheric absorption data for Freiburg on different frequencies were studied for evidence of a lunar variation of absorption and how it varies in periods of different solar activity over nine years, 1956–1965. It was found that the absorption has a diurnal as well as a semidiurnal component, the character of which, on some frequencies, changes in different epochs of solar activity. The diurnal vector rotates anticlockwise and the semidiurnal vector clockwise on the harmonic hour dial proceeding from low to high sunspot epochs. Also, the magnitude of the lunar variation of absorption is larger in winter than in the other two seasons. The phases of the lunar semidiurnal variation of absorption in the D layer very nearly agree with those of f_0F2 and of h′E over a sizable part of the sunspot cycle, but they do not agree with those of H component of the Earth's magnetic field. It is suggested, as one possibility, that the changes in the character of the lunar variation of absorption through different stages of solar activity are introduced by the interaction of the Earth's magnetic field with the wind movement of electrons, which is known to change rapidly with height in magnitude and direction in the 90 to 120-km region at which the radio waves at the frequencies considered are reflected. (auth)

27500 D-REGION ELECTRON DENSITY MEASUREMENTS DURING THE SOLAR ECLIPSE OF MAY 20, 1966. **Kane, J. A.** (Goddard Space Flight Center, Greenbelt, Md.). Planet. Space Sci., 17: 609-16(Apr. 1969).

Rocket and satellite observations of 2 to 8 Å x-ray emissions indicate that the solar eclipse of May 20, 1966, occurred during a period in which the Sun was moderately active. The Goddard Space Flight Center conducted a series of small sounding rocket experiments to measure the ionospheric D-region electron density profile during successive stages of the eclipse. Compared to the uneclipsed profile, an order of magnitude reduction was observed in the D-region profile obtained near totality. From the electron density measurements, together with the x-ray spectral data, it is concluded that on May 20, 1966, 2 to 8 Å x rays were not the dominant source of D-region ionization below approximately 80 km. (auth) (UK)

27501 ROCKET OBSERVATIONS OF ELECTRON DENSITIES IN THE NIGHT-TIME AURORAL E REGION AT FORT CHURCHILL, CANADA. **Reddy, C. A.** (National Center for Atmospheric Research, Boulder, Colo); **Rao, M. Mukunda; Matsushita, S.; Smith, L. G.** Planet. Space Sci., 17: 617-28(Apr. 1969).

Seven rockets were launched into the night-time auroral ionosphere over Fort Churchill, Canada, at different levels of magnetic activity. The rocket-measured electron densities in the 70- to 170-km height range are presented for all the seven cases. Based on these rocket results and simultaneous ionograms and magnetograms, a consistent model of the ionization changes in the auroral E region in relation to the level of local magnetic disturbance is presented. It is shown that increase in magnetic activity is accompanied by (1) a substantial increase of ionization in the entire height range of about 90 to 140 km and (2) by the appearance and rapid variations of small-scale ionization irregularities over a large part of the E region. The semi-transparent portion of the auroral (a-type) E-region trace in ionograms seems to arise from strong scatter-type reflections from these irregularities which are generally "weak." It is shown further that the blanketing frequency (fbEs) gives the (average) maximum plasma density in the auroral E region, while fEs is more sensitive to changes in the size and structure of the ionization irregularities. (auth) (UK)

27502 TWO-DIMENSIONAL MODEL OF THE NEUTRAL SHEET IN THE EARTH'S MAGNETOTAIL. Hruska, A. (Univ. of British Columbia, Vancouver). Planet. Space Sci., 17: 665-73(Apr. 1969).

Relations between magnetic field intensity, plasma pressure, and energy density of macroscopic plasma motion inside the neutral sheet are discussed on the basis of the equations of plasma dynamics assuming that the thickness of the neutral sheet is comparable with a typical proton gyroradius. The electric current density which is required to maintain the neutral sheet and prevent merging of the magnetic field lines is analyzed in connection with the topology of the magnetic lines of force. Only the stationary model is investigated; instabilities which result in an explicit time dependence of physical quantities are not considered. (auth) (UK)

27503 THE N I (${}^4S^0_{3/2} - {}^2D^0_{5/2,3/2}$) TRANSITIONS IN THE UPPER ATMOSPHERE AT NIGHT. Hernandez, G.; Turtle, J. P. (Air Force Cambridge Research Labs., Bedford, Mass.). Planet. Space Sci., 17: 675-84(Apr. 1969).

The forbidden N I (${}^4S^0_{3/2} - {}^2D^0_{5/2,3/2}$) transitions are shown to be a permanent feature of the upper atmosphere at night. This determination was made with a Fabry–Perot spectrometer with a large luminosity–resolution product capable of resolving these transitions. The temporal behaviour of this emission was also measured and can be explained in terms of ionospheric reactions, electron quenching, and molecular oxygen quenching. A value of $2^{+2}_{-1} \times 10^{-4}$ sec^{-1} for the frequency of quenching by molecular oxygen at 230 km was derived from the measurements. (auth) (UK)

27504 DEPENDENCE OF CHARGE AND POTENTIAL DISTRIBUTION AROUND A SPACECRAFT ON IONIC COMPOSITION. Samir, U.; Wrenn, G. L. (University Coll., London). Planet. Space Sci., 17: 693-706(Apr. 1969).

Observations of electron currents, space potentials, and ionic composition obtained by Langmuir-type probes installed on the DME-A (Explorer 31) satellite, were used to study the dependence of the region of disturbance around the satellite on the ionic composition. The ratio of the electron current in the wake of the satellite to the current ahead of the satellite, [I_e(wake)/I_e (front)], was found to vary strongly with the ionic composition; it showed a minimum value at perigee altitudes (500 km) and approached unity at apogee (3000 km). A similar dependence was found for the ratio [ϕ_N(wake)/ϕ_N (front)] where $\phi_N = e\phi_{s.p.}/kT_e$ and $\phi_{s.p.}$ is the effective space potential. This ratio varied from about 0.55 at perigee altitudes to 0.9 at apogee, indicating the type of symmetry of the potential around the satellite's surface. The variation of the electron current and satellite potential with the angle between the normal to the probe and the velocity vector (angle of attack) was studied. The results from the Explorer 31 satellite are in complete agreement with earlier observations obtained from the Ariel I satellite. It is shown that the quantitative measurement of the electron depletion in the wake can serve as a diagnostic tool to measure positive ion composition within a reasonable resolution. A brief discussion of the present state of theoretical and experimental studies is given. The results are compared with other studies. (auth) (UK)

27505 AN IDENTIFICATION OF TWILIGHT HELIUM 10,830-A EMISSION WITH INCREASED RESOLUTION AND PRELIMINARY PHOTOMETRIC MEASUREMENTS. Neo, Y. P.; Rundle, H. N. (Univ. of Saskatchewan, Saskatoon, Can.). Planet. Space Sci., 17: 715-24(Apr. 1969).

A Fabry–Perot instrument was used as a spectrometer, with a resolving power of about 10,000, to study the twilight helium emission at 10,830 Å. Photometric measurements of the atmospheric helium emission were also obtained with the Fabry–Perot spectrometer. Large fluctuating enhancements were recorded in the zenith while visible aurora was present in the sky. The twilight emission intensities were consistent with previous measurements and the rate at which the emission intensity decayed during twilight was consistent with the excitation of triplet helium atoms by collision of photoelectrons with ground state helium atoms, followed by resonance scattering. (auth) (UK)

27506 ASSOCIATIVE DETACHMENT IN THE MESOSPHERE AND THE DIURNAL VARIATION OF POLAR-CAP ABSORPTION. Reid, George C. (Environmental Science Service Administration, Boulder, Colo.). Planet. Space Sci., 17: 731-6(Apr. 1969).

Polar-cap absorption recorded by a variety of high-latitude riometers during the event of September 2–6, 1966, was compared with satellite measurements of solar protons over the polar caps in four different energy ranges. The daytime absorption measurements were found to have a very high correlation with the fluxes of protons in the two higher-energy ranges (8.2 to 25 and 25 to 100 MeV), but a poor correlation with fluxes in the two lower-energy ranges (1.2 to 2.2 and 2.2 to 8.2 MeV). The nighttime absorption measurements, on the other hand, showed a considerably smaller degree of correlation with the higher-energy proton fluxes. These results are shown to be consistent with the suggestion that atomic oxygen plays an important part in maintaining high electron densities in the lower ionosphere through associative detachment reactions. (auth) (UK)

27507 ELECTRON, ION, AND NEUTRAL-GAS TEMPERATURES IN TEMPERATE-LATITUDE SPORADIC-E LAYERS. Hooke, William H. (Inst. for Telecommunication Sciences, Boulder, Colo.). Planet. Space Sci., 17: 737-48(Apr. 1969).

The variations in neutral-gas temperature that accompany tidal and gravity-wave motions of the neutral gas are shown to play a major role in determining the height variations in the electron and ion temperatures through E_s layers of gravity-wave and tidal origin. (auth) (UK)

27508 E-REGION IONOSPHERIC IRREGULARITIES PRODUCED BY INTERNAL ATMOSPHERIC GRAVITY WAVES. Hooke, William H. (Inst. for Telecommunication Sciences, Boulder, Colo.). Planet. Space Sci., 17: 749-65(Apr. 1969).

A linearized perturbation treatment is developed for study of the roles of both photochemical and dynamical effects in the gravity-wave production of E-region innospheric irregularities. It is found that the two effects may be comparable in magnitude. It is also found that the small wave-associated vertical motions of the neutral gas may play a significant role in producing ion convergence. Results of numerical calculations are presented to illustrate these statements. (auth) (UK)

27509 RADIO NOISE OF AURORAL ORIGIN. Ellyett, C. D. (Inst. for Telecommunication Sciences, Boulder, Colo.). J. Atmos. Terrest. Phys., 31: 671-82(May 1969).

A survey was made of all known published literature on radio noise of auroral origin, from the first report in 1946 to the end of 1967. Riometer results from Christchurch, New Zealand, were included. Fifteen positive reports are available from the northern hemisphere and four from the southern hemisphere. Almost all show correlation with periods of aurorae or of high magnetic activity, and events occur mostly at or near the peaks of the two sunspot cycles. Synchrotron radiation appears to explain many of the observations adequately. Noise events observed at widely spaced frequencies, and simultaneous studies of noise and absorption from different directions leave little doubt of the reality of the effect. Suggestions are made for future experiments. (auth) (UK)

27510 TROPOSPHERIC DIFFRACTION PHENOMENA OF RADIO SIGNALS FROM THE BEACON SATELLITE EXPLORER 22. Hartmann, Gerd (Max-Planck-Institut fuer Aeronomie, Lindau/Harz, Ger.). J. Atmos. Terrest. Phys., 31: 663-9 (May 1969).

The amplitude of radio signals from the beacon satellite Explorer 22 was recorded since November 1964 for the purpose of obtaining the ionospheric electron content from the Faraday effect. On a considerable number of occasions when the satellite was at low elevation angles, sudden increases in signal amplitude were observed. From detailed investigations it was concluded that these enhancements are the result of diffraction of the radio waves by structures within the troposphere. These effects were observed on 20, 40, 41, and 136 MHz. (auth) (UK)

27511 ON THE LOCAL AND INTEGRAL ELECTRON DENSITY OF THE IONOSPHERE MEASURED BY MEANS OF COHERENT RADIO WAVES EMITTED FROM ARTIFICIAL EARTH SATELLITES. I. Alpert, Ya. L.; Sinelnikov, V. M. (IZMIRAN, Moscow). J. Atmos. Terrest. Phys., 31: 641-61(May 1969).

Results of experiments with the aid of coherent radio waves emitted by the radio beacon Mayak from the satellite "Electron" are presented. Earlier published results are also considered. Average altitude electron density profiles in the outer ionosphere and data on the integral of the electron density for the equinox of 1964 (February and March, September and October) were obtained. Comparison with similar results obtained with the aid of the Alouette satellite for the same ranges of latitude, longitude, and time during the equinox (September and October, 1963) gives good agreement. A similar agreement is shown by other experiments. According to the data it appears that in the height range 600 to 800 km the electron density often rises; this leads to a maximum of the average altitude profile $\overline{N(z)}$ in the outer ionosphere. Interpretation of this effect does not meet with any principle difficulties. However, its reliability and recurrence require further verification. The spectra of the inhomogeneity sizes and fluctuations of electron density will be given in Part II. (auth) (UK)

27512 VALIDITY OF THE f cos i THEOREM FOR THE ABSORPTION OF VERY LOW FREQUENCY RADIOWAVES IN THE IONOSPHERE. **Jones, T. B.; Wand, I. C. (Univ. of Leicester, Eng.). Nature (London), 222: 462-3(May 3, 1969).**

Reference is made to Martyn's theorem (Proc. Phys. Soc. 47: 323 (1935)) which indicates that, provided the effect of the Earth's magnetic field is neglected, the absorption of a radiowave of frequency *f* incident obliquely on the ionosphere at an angle of incidence *i* is equal to the absorption of a vertically incident wave of frequency *f* cos *i* multiplied by cos i. Experimental investigations, however, indicated that accuracy was improved if the cos i multiplying factor was omitted, and later theoretical work supported omission of the cos i term. It has been assumed that for a particular ionosphere the reflexion coefficients are a unique function of *f* cos *i*; to test this assumption the reflexion parameters for various ionospheric models were evaluated by means of the full-wave method; it was found that the reflexion coefficient at a particular value of *f* cos *i* had no unique value. Calculations were repeated with the electron collision frequency increased by a factor of 100, and reflexion coefficients are shown as a function of *f* cos *i* for each frequency. Results indicate that for a given value of *f* cos *i* the reflexion coefficients are approximately the same for all frequencies, in agreement with a modified theorem; the results are, however, for an idealised layer with a collision frequency greatly in excess of the values normally ascribed to D-region heights. Quasi-Brewster angles are considered, and it is concluded that the reflexion coefficient may change in a complicated manner with *f* cos *i*. The calculations were confined to frequencies below 100 kHz. It is only for a physically unrealistic model having a very high collision frequency that the calculated values of the reflexion coefficient show some degree of agreement with the *f* cos *i* law. (UK)

27513 STUDY OF THE EFFECT OF CROSSING THE LOWER IONOSPHERE AND OF THE EARTH–IONOSPHERE WAVEGUIDE ON THE GROUND POLARIZATION OF RADIOELECTRIC WHISTLERS. **Lacoume, J.-L. (Faculte des Sciences, Paris). Ann. Geophys., 24: 973-90(Oct.-Dec. 1968). (In French).**

In view of the interpretation of the experimental results obtained by simultaneous measurements of the plane wave normal direction and polarization of whistlers, an approximative analytical study and a computer program of the lower ionosphere transmission and reflection properties for vlf are presented. The effect of the Earth–ionosphere waveguide is determined. The characteristics of the polarization are seen to be drastically modified by waveguide resonances. Finally a method of determination of the lower ionosphere reflection height from the simultaneous measurement of whistler emergence direction and ground polarization is suggested. (auth)

27514 ATOMIC NITROGEN AND NITRIC OXIDE IN THE UPPER ATMOSPHERE DURING DAY TIME. **Saxena, P. P. (Uttar Pradesh State Observatory, Naini Tal, India). Ann. Geophys., 24: 1023-30(Oct.-Dec. 1968).**

Daytime production and loss mechanisms of atomic nitrogen and nitric oxide in the upper atmosphere were investigated and their profiles were found. The region investigated ranged from 150 to 240 km. The atomic nitrogen and nitric oxide densities at 150 km were found to be, respectively, $8.58 \times 10^6/\text{cm}^3$ and $6.14 \times 10^6/\text{cm}^3$, which change to $1.24 \times 10^7/\text{cm}^3$ and $5.13 \times 10^5/\text{cm}^3$, respectively, at 240 km. The concentration of atomic nitrogen was found to have a maximum around 200-km altitude. The role of ion–neutral reactions and diffusion is also discussed. (auth)

27515 CALCULATION OF LIGHT EMISSIONS ASSOCIATED WITH PCA IN THE 3914- AND 5577-A BANDS. **Alcayde, Denis (Centre d'Etude Spatiale des Rayonnements, Toulouse). Ann. Geophys., 24: 1031-5(Oct.-Dec. 1968). (In French).**

The solar-particle energy dissipation in the atmosphere was calculated for different particle spectra. The ionization profiles were used in the determination of the 3914- and 5577-Å transition rates. The relative variations of these two emission intensities were evaluated. (auth)

27516 ABNORMAL ELECTRON DENSITY DISTRIBUTIONS OVER HUANCAYO ON DISTURBED DAYS OF IGY/IGC. **Rajaram, Girija; Rastogi, R. G. (Physical Research Lab., Ahmedabad, India). Ann. Geophys., 24: 1045-51(Oct.-Dec. 1968).**

Studying the midday value of f_0F2 at Huancayo during 1938 to 1962, it has been found that f_0F2 is higher on disturbed (D) than on (Q) quiet days during either of the solstices, except during the December solstices of 1957 to 1960. The ratio of midday f_0F2 on D and Q days shows inverse relationship with sunspot number during December solstices. The N–h profiles at Huancayo, Puerto Rico, and Fort Monmouth during D and Q days indicate that the changes occur generally above the level of 200 km; the electron density is increased at Huancayo and decreased at Fort Monmouth, for either of the seasons, while at Puerto Rico, the electron density increases during winter, and decreases during summer months of 1961. Disturbance daily variation during 1961 shows that the major changes occurred around the midday hours. During November of 1957-58 at Huancayo and Chimbote, the electron density at any height above 300 km was lower on disturbed than on quiet days while during July the electron density was higher on D than on Q days. The D_{st} variations of f_0F2 in any of the seasons of low, as well as high sunspot years, show a positive type of variation, f_0F2 on storm days being higher than normal. The D_{st} variation seems to be more prominent during the low sunspot years, and continues for a longer period than during high sunspot years, indicating some kind of saturation effect on the equatorial ionosphere during high sunspot years. (auth)

27517 D-REGION PARAMETERS MEASURED BY PARTIAL REFLECTIONS AT VARYING PULSE WIDTHS. **Beer, T. I. (Univ. of Canterbury, Christchurch, New Zealand). Ann. Geophys., 24: 1069-71(Oct.-Dec. 1968).**

Using one component of the partially reflected echoes from the lower ionosphere a new analysis which compares the amplitudes at the leading edge and the center of pulses of varying widths is used to obtain electron density profiles from 70 to 90 km. It is assumed that the returned echoes are due to volume scattering by stochastic irregularities in refractive index and the resulting values for electron density are compared with those obtained, using the differential absorption experiment. (auth)

27518 THE UPPER ATMOSPHERE AS A REGULATOR OF GEOMAGNETIC STORMS, SUBSTORMS, AND AURORAS. **Krassovskii, V. I. (Inst. of Physics of the Atmosphere, Moscow). Ann. Geophys., 24: 1053-67(Oct.-Dec. 1968).**

Geomagnetic storms, substorms, and auroral displays are a function of two groups of independent and little-dependent processes in the solar wind and in the Earth's upper atmosphere. Spectroscopic investigations into intense auroras have shown that electrons and protons which are their excitation agents, are often injected into the atmosphere separately in adjacent regions. Aurora excitation electrons freely penetrate into the E region of the ionosphere. However, their low-energy partners, protons in the main, have energies of about 500 eV and therefore cannot penetrate into the same depth. For the appearance of intense auroras and substorms good electric conductivity is required between proton and electron injection zones. Such electric conductivity can be secured only in case of a "fair" wind when the ionized atmosphere from electron injection zones is transferred below proton injection zones. (auth)

27519 STUDIES OF SUDDEN CHANGES IN H AND Z AT EQUATORIAL STATIONS IN THE INDIAN ZONE. **Trivedi, N. B.; Rastogi, R. G. (Physical Research Lab., Ahmedabad, India). Ann. Geophys., 24: 1037-43(Oct.-Dec. 1968).**

The storm-time commencements (SC) and sudden impulses (SI) in H and Z at equatorial stations in the Indian zone during IGY/IGC are discussed. The amplitudes of both SC and SI in H at the equatorial stations are enhanced during the midday hour. At any particular hour during the daytime the amplitudes are enhanced over a narrow zone over the magnetic equator. There is no distinct latitudinal enhancement of SC or SI during nighttime but the amplitudes are significantly higher at Annamalainagar. The latitudinal variation of the amplitude of SC in Z in Indian zone do not conform to the simple thin sheet model of the electrojet and the interpretation should be sought in the abnormal induced currents. (auth)

27520 BIMODAL DIFFUSION IN THE EARTH'S MAGNETOSPHERE. II. ON THE ELECTRON BELTS. **Theodoridis, G. C.; Paolini, F. R.; Frankenthal, S. (American Science and Engineering, Inc., Cambridge, Mass.). Contract F 19628-67-C-0277. Ann. Geophys., 24: 1015-22(Oct.-Dec. 1968).**

The formation and storm-time behavior of the trapped electron belts are examined with the help of a computer model which assumes the presence of bimodal diffusion from a low-energy source at the outer edge of the magnetosphere. Acceleration through bimodal diffusion generates an outer belt of energetic electrons with spatial features governed by the L-dependence of the particle transition probabilities for undergoing the two different diffusion modes. If magnetic storms are simulated by enhancing constant-μ diffusion over constant-E diffusion and displacing the trapping boundary inward, low-energy electron intensities in the outer belt rise, while high-energy electrons are depleted at the start of the storm and replenished subsequently. At very infrequent intervals, unusually strong events may push electrons into the inner-belt region. Once there, these electrons may remain trapped for a long time due to the relative infrequency of strong perturbing mechanisms in that region. (auth)

27521 BIMODAL DIFFUSION IN THE EARTH'S MAGNETOSPHERE. I. AN ACCELERATION MECHANISM FOR TRAPPED PARTICLES. Theodoridis, George C. (American Science and Engineering, Inc., Cambridge, Mass.). Contract F 19628-67-C-0277. Ann. Geophys., 24: 999-1013(Oct.-Dec. 1968).

Trapped particles can be accelerated or decelerated by diffusing at random in L via two diffusion modes, one that conserves the first adiabatic invariant μ and the other that conserves the particle energy E. Acceleration through such "bimodal diffusion" is most efficient when the two diffusion modes are present in comparable strengths. A computer model is used to study the effect of bimodal diffusion on particle intensity profiles and energy spectra in a variety of conditions. Analytical solutions are also obtained using certain simplifying assumptions. (auth)

27522 STUDY OF SYNCHROTRON RADIATION FROM ENERGETIC ELECTRONS IN THE MAGNETOSPHERE. I. Singh, R. N.; Singh, R. P. (Banaras Hindu Univ., India). Ann. Geophys., 24: 991-8(Oct.-Dec. 1968).

The total synchrotron power radiated by relativistic electrons in the magnetosphere for certain frequency ranges was calculated. The variation of total synchrotron power along the lines of force at different height was calculated. The radiated power from the equatorial region was found to be maximum and decreases with increasing latitude. The integrated synchrotron power at a fixed frequency from various heights was found to show a secondary power maximum at nonequatorial heights. The location of the secondary maximum along the lines of force varies with the radiated frequencies. The effect of pitch-angle distribution is discussed. The possibility of synchrotron power reception at ground-based stations is discussed, and it is argued that the coherence radiation due to electron influx bunching increases the radiated power n-fold. (auth)

27523 INTERPRETATION OF MEASUREMENTS OF THE VLF ELECTROMAGNETIC FIELD IN THE MAGNETOSPHERE. Grard, Rejean (CNRS, Saint-Maur-des-Fosses, France). Ann. Geophys., 24: 955-71(Oct.-Dec. 1968). (In French).

The FR-1 satellite measures three components of the magnetic field and two components of the electric field of a vlf wave transmitted from the ground. In interpreting the measurements, the first task is to restore the missing component of the electric field. It is then possible to check that the reconstituted electromagnetic wave presents the features expected of a plane wave propagated in the whistler mode, and this confirms that the techniques of measurement and of restoration of the missing field component are valid. The refractive index and the electron density of the medium are computed also from the relative strengths of the magnetic and electric fields, and they agree with the value found from the vlf Doppler effect and direct electron density measurement. (auth)

Low-Temperature Physics

Refer also to abstracts 26427, 27708, 27733, 27920, 28083, 28103–28106, and 28206.

27524 "SELF-FIELD" LIMITING OF JOSEPHSON TUNNEL CURRENT. Mahutte, C. K.; Leslie, J. D.; Smith, H. J. T. (Univ. of Waterloo, Ont.). Can. J. Phys., 47: 627-9(Mar. 15, 1969).

As was first predicted by Ferrell and Prange, the Josephson tunnel current is limited to a strip of width approximately $2\lambda_J$, where λ_J is the Josephson penetration distance, along the edges of the junction due to the magnetic field produced by the tunnel current itself. Using the symmetric geometry of Owen and Scalapino, the maximum zero voltage dc current, I_0, was investigated in a zero applied magnetic field of Sn–SnO–Sn junctions with widths $W \sim \lambda_J$ and various lengths L. The experimental data are compared with the theory of Owen and Scalapino by plotting $(LI_0)/(2\lambda_J W J_1)$ versus L/λ_J, where J_1 is the tunnel current density without self-limiting. The results are in reasonable agreement with the theory, except that I_0 tends to be less than predicted. However in most junctions the usual Fraunhofer pattern of maximum zero voltage dc current versus applied magnetic field is skewed, and better agreement with theory is obtained if the maximum zero voltage dc current in a magnetic field is used instead of I_0. (auth)

27525 MEASUREMENT OF CURRENT DISTRIBUTIONS IN THIN-FILM SUPERCONDUCTORS. Rosner, Leonard George. Minneapolis, Univ. of Minnesota, 1968. 147p.

Thesis.

An ac modulation technique was developed to measure small rotations in the plane of polarization of a light beam so that the optical Faraday effect in cerous phosphate glass could be used to measure magnetic field distributions above a thin superconducting film. Magnetic field measurements were made on evaporated vanadium films, 2 cm long by 6 mm wide by 2000-Å thick, at 4.2°K as a function of both applied current and applied magnetic field normal to the plane of the film. The measurement system used had a magnetic field sensitivity of 0.2 Oe and a spatial resolution of 0.25 mm. The distribution of current flowing in the film was calculated from the measured magnetic field distribution by replacing the integral expression between the current and magnetic field with a finite sum and solving the resulting linear system of equations for the current distribution. Data smoothing and data correction procedures were necessary to remove the effects of small errors in the measured magnetic field data. The measured current distribution for the case of an applied transport current had the maximum current density at the film edges and a minimum at the center of the film in good agreement with the published analytical expression. No appreciable change was observed when the current was varied by a factor of six from the critical current or when the applied magnetic field was varied from 0 to 176 Oe. From critical current versus applied magnetic field measurements with the film width as a parameter, it can be concluded that the pattern of current flow gradually changes as the applied field is increased becoming uniformly distributed when the applied magnetic field exceeds 1500 Oe. By treating the film as a set of coupled inductors, a transport current distribution can be calculated which is very similar both to the measured results and the analytical expression. This coupled inductor model was extended to the case of induced current flow produced by a small change in the value of the applied magnetic field. The calculated distributions for this case were also in good agreement with the measured results. (Diss. Abstr.)

27526 FLUX PINNING BY GRAIN BOUNDARIES IN SUPERCONDUCTING NIOBIUM–ZIRCONIUM ALLOYS. Love, G. R.; Koch, C. C. (Oak Ridge National Lab., Tenn.). Appl. Phys. Lett., 14: 250-2(Apr. 15, 1969).

The influence of grain, subgrain, or dislocation-cell size d or superconducting critical flux gradient dB/dr was investigated in a single-phase Nb–33 at. % Zr alloy. By appropriate heat treatments, d was varied from 0.25 to 1500 μ. A monotonic decrease of more than one hundred-fold in dB/dr accompanied this thousandfold increase in d. At a given d, the maximum increase in dB/dr obtained from precipitation of a second phase does not exceed a factor of about 30. (auth)

27527 ENTRAINMENT OF SECOND SOUND IN STEADY-STATE COUNTERFLOWING NORMAL AND SUPERFLUID HELIUM II. Johnson, Earl M.; Hildebrandt, Alvin F. (Univ. of Houston, Tex.). Phys. Rev., 178: 292-4(Feb. 5, 1969).

The velocity dependence of second sound in liquid helium was measured as a function of the relative velocity $(\vec{v}_n - \vec{v}_s)$, where $\vec{v}_n$ is the normal fluid velocity and $\vec{v}_s$ is the superfluid velocity. The experimental technique consisted of measuring the time of flight of a second-sound pulse in steady-state counterflowing normal and superfluid for subcritical velocities. The results are in agreement with the theoretical predictions by Khalatnikov. (auth)

27528 STATES OF AGGREGATION. Mendelssohn, Kurt (Wolfson Coll., Oxford). Phys. Today, 22: No. 4, 46-51(Apr. 1969).

Superfluidity and superconductivity are discussed as states of aggregation. Paralleling solids, liquids, and gases as condensates in position space, superfluids and superconductors are presented as condensates in momentum space. The ideas presented are extended to the possibilities of various types of ordering which may exist elsewhere in the universe. The possibility of living matter being a mixed condensate embodying both position and momentum order is discussed. (M.H.R.)

27529 CRYOGENIC EQUIPMENT FOR NUCLEAR RESEARCH. Giger, U. Sulzer Tech. Rev., 50: 175-80(1968).

Sulzer has engineered two cryogenic refrigerators producing temperatures of 4.5 and 14°K for the nuclear research establishment at Jülich, Germany. One plant is also capable of liquefying helium, para-hydrogen and neon. The layout and mode of operation of the cryogenic plants and in-pile systems are described. (auth)

27530 ISOTOPE EFFECT IN SUPERCONDUCTING GALLIUM. Fassnacht, R. E.; Dillinger, J. R. (Univ. of Wisconsin, Madison). Phys. Lett., 28A: 741-2(Mar. 10, 1969).

The superconducting transitions of ^{69}Ga, natural Ga, and ^{71}Ga have been measured. The transition temperatures T_c were found to be 1.0897 ± 0.0003, 1.0845 ± 0.0003 and 1.0770 ± 0.0003 respectively, giving $z = 0.41 \pm 0.02$ and $\zeta = 0.17 \pm 0.04$ as parameters in $T_c \propto M^{-z} = M^{-0.5(1-\zeta)}$. (auth)

27531 EXPERIMENTAL EVIDENCE FOR SUPERCONDUCTIVITY ENHANCEMENT MECHANISM. Leger, A.; Klein, J. (Faculte des Sciences, Paris). Phys. Lett., 28A: 751-2 (Mar. 10, 1969).

Tunneling characteristics in junctions made of granular Al exhibit a low-frequency tail in the phonon spectrum. This supports the explanation for the superconducting transition temperature enhancement based on MacMillan's theory. (auth)

27532 DEPENDENCE OF SUPERCONDUCTING MAGNETIZATION CURVES ON DEMAGNETIZATION COEFFICIENTS. Aston, D. (Temple Univ., Philadelphia); Dubeck, L. W.; Rothwarf, F. Phys. Lett., 28A: 774-5(Mar. 10, 1969).

The dependence of the magnetic moments of In + 3 at. % Bi samples on their demagnetization coefficients was measured and found to agree with the calculations of Cape and Zimmerman (Phys. Rev., 153: 416(1967)). (auth)

27533 ENTROPY OF THE SUPERFLUID COMPONENT OF HELIUM. Glick, Forrest I.; Werntz, James H. Jr. (Univ. of Minnesota, Minneapolis). Phys. Rev., 178: 314-19(Feb. 5, 1969).

The specific entropy deficit $\Delta s = s - s_s$ of the superfluid component of liquid helium II was determined over the temperature range 1.27 to 1.93°K. Here s and s_s are the specific entropy of the bulk liquid and of the superfluid component, respectively. Superfluid was transferred into a thermally isolated reservoir from a constant-temperature reservoir by film flow. Values of Δs were determined from flow rates obtained by driving the film by thermal means. Flow rates were measured with a capacitor depth gauge. The present results indicate that $\Delta s = s$ within ±3%. (auth)

27534 HIGH-PRESSURE STUDY ON SUPERCONDUCTIVITY OF TRANSITION METALS AND ALLOYS. Chu, Ching-wu. San Diego, Calif., Univ. of California, 1968. 163p.
Thesis.

Results are presented of high-pressure measurements on the superconducting transition temperatures T_c ($\gtrsim$1.18°K) of the transition elements Re, Tc, V, Nb, and Ta; alloys Re–Os, Re–W, Re–Mo, Re–Ru, and V–Cr; and compounds ZrB_{12}^{10} and ZrB_{12}^{11} (the superscripts 10 and 11 are mass numbers of different isotopes of boron). T_c of Re exhibits an anomalous pressure dependence attributed to a change of Fermi surface topology under hydrostatic compression, while that of Tc has a linear pressure dependence with $\partial T_c/\partial P = -(1.25 \pm 0.05) \times 10^{-5}$°K bar^{-1}. No simple correlation between $\partial T_c/\partial P$ and T_c, number of valence electrons per atom n_ν, and the density of electron states N(0) at the Fermi surface can be found. The correlation proposed by Brandt and Ginzburg that $\partial T_c/\partial P > 0$ if $\partial N(0)/\partial P > 0$ or vice versa does not hold generally. In non-transition metal superconductors (except phosphorus and thallium; Tl has $\partial T_c/\partial P > 0$ at $P \lesssim 2$ kbar and $\partial T_c/\partial P$ changes sign at higher pressure because of Fermi surface topology change), $\partial T_c/\partial P$ is always negative. The transition series has $\partial T_c/\partial P$ of both signs. Study of the pressure influence on the isotope effect of boron in ZrB_{12} suggests that the repulsive interaction V_r can be correlated with the repulsive interaction V_c^* responsibile for the deviation of from 0.5 ($T_c \sim M^{-\alpha}$, where M is the isotopic mass of the ion, and α is a constant) for the transition metals. Therefore it is further proposed that for those of the superconducting transition metals which have $\partial T_c/\partial P > 0$, α is small, and can be zero or even negative (e.g., V and Ti). It has been pointed out that in the middle of the d-transition series elements have very large cohesive energies, very high melting points, and very low densities of states. Hence elements with d^5-electron configuration are in a very stable state, the so-called "antiresonant" state, which leads to the appearance of a minimum in the T_c vs. N_ν curve. The variation of T_c and $\partial T_c/\partial P$ of Re with the additions of different solutes suggests that the existence of a half-filled d-shell electron configuration is essential for the appearance of any symmetry of the superconducting properties in agreement with this hypothesis. (TSS)(Diss. Abstr.)

27535 THEORY OF THE OSMOTIC PRESSURE OF DILUTE SOLUTIONS OF ^{3}He IN ^{4}He. Seiden, Joseph (Faculte des Sciences, Orsay, France). J. Phys. (Paris), 30: 267-76(Feb.-Mar. 1969). (In French).

The osmotic pressure Π of dilute solutions of ^{3}He in superfluid ^{4}He is evaluated by a second-order perturbation calculation in U(r), the interaction potential between two atoms of ^{3}He in ^{4}He. For concentrations of ^{3}He below 0.5% and temperatures below 0.1°K, it is shown that satisfactory expressions of Π can be given in which U(r) enters only by its second and fourth "moments." The theoretical and experimental values of Π seem in agreement at low temperatures $T \ll T_F$ (T_F, the Fermi temperature of the ^{3}He). In the semiclassical region $T \simeq T_F$, the influence of U(r) on Π can only be seen at temperatures below 0.1°K. (auth)

27536 THE TEMPERATURE DEPENDENCE OF THE CRITICAL FIELD RATIO H_{c3}/H_{c2} OF SUPERCONDUCTORS. Fischer, Gaston (Univ. of Montreal). Solid State Commun., 7: 611-13 (Apr. 15, 1969).

Experimental values of the ratio of critical fields H_{c3}/H_{c2} of two alloys ($\mathrm{Pb}_{91}\mathrm{Bi}_9$ and $\mathrm{Pb}_{83}\mathrm{In}_{17}$) are presented. The data confirm a new theory of this ratio for dirty superconductors and allow a derivation of such microscopic parameters as mean free path l, BCS coherence length ξ_0, and Fermi velocity ν_F for the alloys. (auth)(UK)

27537 SPECIFIC HEAT OF SUPERCONDUCTING LEAD–INDIUM ALLOYS. Culbert, Harvey V. (Argonne National Lab., Ill.); Farrell, D. E.; Chandrasekhar, B. S. Solid State Commun., 7: 571-4(Apr. 15, 1969).

Specific heat measurements were made in the normal and superconducting states of the fcc lead–indium alloy system. When corrected for mass renormalization due to the electron–phonon coupling, the normal state electronic specific heat coefficient showed semi-quantitative agreement with the rigid band model for these alloys. κ_1 was also obtained and showed significant deviations from theoretical predictions. (auth)(UK)

27538 A NOTE ON THE SUPERCONDUCTING MAGNETIC SHIELD. Yoshihiro, Kazuo. Denki Shikensho Iho, 32: 1195-9 (1968). (In Japanese).

A superconducting magnetic shield is discussed as one of simple and effective ways to avoid the effect of the earth magnetic field and stray field. (auth)

27539 CRITICAL CURRENT OF SUPERCONDUCTING Nb–Zr–Ti TERNARY ALLOYS IN MAGNETIC FIELD. Doi, Toshio; Ishida, Fumihiko (Hitachi Ltd., Tokyo). Hitachi Hyoron, 50: No. 12, 1-6(Dec. 1968). (In Japanese).

The effect of precipitation of Nb–40Zr–10Ti and Nb–5Zr–60Ti alloys on the allowable critical current density J_c in the right-angle magnetic field H was investigated. In general, J_c becomes high when dislocations and precipitates are introduced by subjecting alloys to working or heat treatment and their structures are made heterogeneous. From the former studies, the microstructure and distribution of precipitates as well as the kind of precipitates enter into the question of pinning. The precipitating processes in $\beta \rightarrow \beta' + \beta''$ transformation of Nb–40Zr–10Ti alloy at 700°C and $\beta \rightarrow \alpha + \beta$ transformation of Nb–5Zr–60Ti alloy at 500°C were analyzed with an optical microscope, an electron microscope, x-ray diffraction, measurements of hardness and electric resistance, and tensile test, and $H-J_c$ characteristics, the critical temperatures T_c, and the critical magnetic fields H_c of samples heat-treated at these temperatures were measured. The samples and the method and results of the experiment are described. J_c becomes high owing to pinning of magnetic fluxes by β' phase, produced in the transformation of Nb–40Zr–10Ti alloy, which forms the weaker superconductor, and by α phase, produced in the transformation of Nb–5Zr–60Ti alloy, which forms the normal conductor. The pinning effect becomes highest when the structure is refined and β' and α phases are brought to the order of coherence length. (NSA of Japan)

27540 TRANSIENT HEAT TRANSFER AND STABILITY OF SUPERCONDUCTING COMPOSITES. Jackson, J. (Mullard Research Lab., Redhill, Eng.). Cryogenics, 9: 103-5(Apr. 1969).

The rate of change of temperature with Joule heating of a sample in liquid helium is dependent on the specific heat and thermal conductivity of the sample and the heat transfer coefficient to liquid helium. By measuring the temperature of a sample of manganin wire in liquid helium during the first few milliseconds of Joule heating very high heat transfer coefficients at heat flux densities as high as 3 W cm^{-2} were measured. The results were used to describe a form of enthalpy stabilization in minimum propagating current coils. (auth)(UK)

27541 DESIGN OF HIGH-HOMOGENEITY INSIDE-NOTCH-CORRECTED SUPERCONDUCTING SOLENOIDS. Atherton, David (Ferranti-Packard Electric Ltd., Toronto). Can. J. Phys., 47: 753-6(Apr. 1, 1969).

A graphical technique is described that facilitates the design of high-homogeneity solenoids corrected to sixth order by a notch on the inner surface of the coil. (auth)

27542 POSITRON ANNIHILATION IN SUPERCONDUCTIVE METALS. Dekhtyar, I. Ya. (Inst. of Metalphysics, Kiev). Phys. Lett., 28A: 771-2(Mar. 10, 1969).

A correlation is shown between the parameters of superconductive metals and those of positron annihilation. Particular attention is paid to the density states obtained from the electron specific heat. (auth)

27543 TYPE I TO TYPE II TRANSITION IN SUPERCONDUCTING In–3.9 AT. PERCENT Pb ALLOY. Noto, Koshichi (Research Inst. for Iron, Steel, and Other Metals, Tohoku, Japan). Sci. Rep. Res. Inst., Tohoku Univ., Ser. A, 20: 129-39(Dec. 1968).

The magnetization and the thermal conductivity of In–3.9 at.% Pb alloy are measured between 1 and 4.2°K. It is found that this alloy sample does show type I-to-type II transition of the superconductivity at $T_{cr} = 2.2°K$. Below T_{cr}, the magnetization decreases with finite slope near the upper critical field, H_{c2}, and the thermal conductivity shows deep minima both in the magnetic field dependence and in the temperature dependence. Above T_{cr}, on the other hand, the sample does not show any such effects mentioned above. The data concerning the residual resistivity $\rho_n = 2.46\ \mu\Omega$ cm, the transition temperature $T_c = 3.64°K$, the mean free path $l = 5.96 \times 10^{-6}$ cm, the G–L parameters $\kappa_1(0) = 0.77$ (at 0°K), $\kappa_1(1) = 0.68$ (at T_c) and the ratio $\kappa_1(0)/\kappa_1(1) = 1.13$ are obtained. These values are all in good agreement with the results of previous investigations on In–Pb alloys. (auth)

27544 DIFFERENTIAL RESISTANCE OF SUPERCONDUCTORS OF THE SECOND KIND. Fogel, I. Ya.; Volotskaya, V. G.; Korovin, L. N.; Dmitrenko, I. M. (Physico-Technical Inst. of Low Temperatures, Kiev). JETP Lett. (USSR) (Engl. Transl.), 9: 105-8(Feb. 5, 1969).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 9: 180-4(Feb. 5, 1969).

The current–voltage characteristics were measured in single-crystal and polycrystalline samples of Pb–In alloys with concentrations from 22 to 24 at. % In for a wide range of fields. The critical current I_c and the resistance R are plotted against the magnetic field H for all samples. These plots show that surface superconductivity is observed in fields stronger than H_{c2}. (M.H.R.)

27545 SOUND ABSORPTION IN SUPERFLUID He NEAR THE λ POINT. Pokrovskii, V. L.; Khalatnikov, I. M. JETP Lett. (USSR) (Engl. Transl.), 9: 149-52(Feb. 20, 1969).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 9: 255-8(Feb. 20, 1969).

The question of sound absorption near the λ point is reconsidered and it is shown that the result of Landau and Khalatnikov remains valid, in a certain sense, under much broader assumptions. It is assumed that the critical phenomena are described by only one characteristic length ξ, which coincides with the correlation radius of the phase of the wave function. (M.H.R.)

27546 ANOMALOUS SCATTERING DUE TO MAGNETIC IMPURITIES IN GAPLESS SUPERCONDUCTOR. Maki, Kazumi (Tohoku Univ., Sendai). Progr. Theor. Phys. (Kyoto), Suppl. Extra No., 211-21(1968).

Making use of Suhl's dispersion equation for the scattering matrix in a superconductor, the effect of the anomalous scattering due to magnetic impurities in the gapless superconductor is investigated. For $T_{c0} > T_k$, where T_{c0} is the superconducting transition temperature in the absence of magnetic impurities and T_k is the resonance temperature due to the spin-exchange scattering, the shift of the transition temperature is obtained. A difficulty in extending the approach for the system with $T_{c0} < T_k$ is pointed out. (auth)

27547 SUPERCONDUCTING ALLOY. Savitskii, E. M.; Baron, V. V.; Efimov, Yu. V. Russian Patent 223,357. (In Russian).

This Author Certificate introduces a superconducting alloy containing vanadium and titanium. To increase its strength and ductility, tungsten is added to the alloy. Its composition is 60.5 to 40.5% titanium, 0.01 to 0.95% tungsten, and remainder vanadium. (ATD)

27548 SUPERCONDUCTIVITY. VOLUMES 1 AND 2. Parks, R. D. (ed.). New York, Marcel Dekker, Inc., 1969. 1439p. $75.00.

These two volumes review the present state of knowledge about superconductivity. Volume 1 covers what might be called classical superconductivity. Volume 2, while also containing well-understood topics, treats many unresolved problems. Twenty-three chapters are included in the two volumes and separate abstracts were prepared for each chapter. (M.H.R.)

For abstracts of individual papers see: 27549–27571.

27549 EARLY EXPERIMENTS AND PHENOMENOLOGICAL THEORIES. Chandrasekhar, B. S. (Case Western Reserve Univ., Cleveland). pp 1-49 of Superconductivity. Vols. 1 and 2. Parks, R. D. (ed.). New York, Marcel Dekker, Inc., 1969.

The state of the knowledge of superconductivity, both experimental and theoretical, is reviewed as it was in 1957 when the microscopic BCS theory was formulated. The fundamental properties which distinguish a superconductor from other solids and its behavior in mechanical, thermal, and electromagnetic fields are recounted. The thermodynamics of superconductors and the several phenomenological theories proposed to explain these properties are discussed. 93 references. (M.H.R.)

27550 THEORY OF BARDEEN, COOPER, AND SCHRIEFFER. Rickayzen, G. (Kent Univ., Canterbury, Eng.). pp 51-115 of Superconductivity. Vols. 1 and 2. Parks, R. D. (ed.). New York, Marcel Dekker, Inc., 1969.

The following topics are covered: a normal Fermi liquid, Cooper's problem, the reduced Hamiltonian, the self-consistent solution, the criterion for superconductivity, the critical temperature, the energy gap, the excitation spectrum, thermodynamic functions, the wave function, the complete Hamiltonian, spin susceptibility of the electrons, the effects of transverse electromagnetic fields; Meissner effect and penetration depth, the effects of varying transverse electromagnetic fields, infinite conductivity, ultrasonic attenuation, the thermal conductivity of the electrons, tunneling of electrons, and nuclear spin relaxation time. 100 references. (M.H.R.)

27551 EQUILIBRIUM PROPERTIES: COMPARISON OF EXPERIMENTAL RESULTS WITH PREDICTIONS OF THE BCS THEORY. Meservey, R.; Schwartz, B. B. (Massachusetts Inst. of Tech., Cambridge). pp 117-91 of Superconductivity. Vols. 1 and 2. Parks, R. D. (ed.). New York, Marcel Dekker, Inc., 1969.

The subjects covered are: the nature of the electron–electron interaction and pairing, the density of states and the energy gap as determined by tunneling, the equilibrium thermodynamic properties, including the specific heat, the critical field, and the pressure dependence of the transition temperature, and equilibrium electromagnetic properties, including the penetration depth and Knight shift. 249 references. (M.H.R.)

27552 NONEQUILIBRIUM PROPERTIES: COMPARISON OF EXPERIMENTAL RESULTS WITH PREDICTIONS OF THE BCS THEORY. Ginsberg, D. M. (Univ. of Illinois, Urbana); Hebel, L. C. pp 193-257 of Superconductivity. Vols. 1 and 2. Parks, R. D. (ed.). New York, Marcel Dekker, Inc., 1969.

Experimental and theoretical results are presented concerning four types of experiments: infrared and microwave absorption, ultrasonic attenuation, nuclear spin–lattice relaxation, and thermal conductivity. These results show considerable departure from predictions of the older two-fluid model and excellent confirmation of the spin–momentum pairing introduced in the BCS theory. 202 references. (M.H.R.)

27553 GREEN'S FUNCTION METHOD. Ambegaokar, Vinay (Cornell Univ., Ithaca, N. Y.). pp 259-319 of Superconductivity. Vols. 1 and 2. Parks, R. D. (ed.). New York, Marcel Dekker, Inc., 1969.

The methods of quantum field theory are introduced as they apply to many-particle systems, particularly to superconductors. The Green's function method and its usefulness in the study of superconductivity are discussed. Topics covered are: properties of Green's functions, Green's functions of a superconductor, thermodynamic properties, absorption of energy, and the effects of impurities. 27 references. (M.H.R.)

27554 THE GINZBURG–LANDAU EQUATIONS AND THEIR EXTENSIONS. Werthamer, N. R. (Bell Telephone Labs., Inc., Murray Hill, N. J.). pp 321-70 of Superconductivity. Vols. 1 and 2. Parks, R. D. (ed.). New York, Marcel Dekker, Inc., 1969.

Topics covered are: the phenomenological approach, Gor'kov's derivation from microscopic theory, extensions of the Ginzburg–Landau equations, and the time-dependent Ginzburg–Landau equations. The specific extensions of the Ginzburg–Landau equations discussed are: slow variations, small-order parameter in the local limit, spin paramagnetism, nonlocality, anisotropy of the Fermi surface, and Landau diamagnetism. 56 references. (M.H.R.)

27555 COLLECTIVE MODES IN SUPERCONDUCTORS. Martin, Paul C. (Harvard Univ., Cambridge, Mass.). pp 371-91 of Superconductivity. Vols. 1 and 2. Parks, R. D. (ed.). New York, Marcel Dekker, Inc., 1969.

The example of the neutral superconductor with its longitudinal collective mode is described; then the way the correlations responsible for this collective mode remove the objectionable features of calculations in the charged superconductor, without producing a collective mode, is discussed briefly. Next, the strongly coupled neutral superconductor, that is, hypothetically superfluid ^{3}He, is covered and the way the interactions modify various possible collisionless modes, low-frequency modes, is indicated. Possible exciton modes are discussed. 35 references. (M.H.R.)

27556 MACROSCOPIC QUANTUM PHENOMENA. Mercereau, James E. (Ford Scientific Lab., Newport Beach, Calif. California Inst. of Tech., Pasadena). pp 393-421 of Superconductivity. Vols. 1 and 2. Parks, R. D. (ed.). New York, Marcel Dekker, Inc., 1969.

The idea of superconductivity as a macroscopic quantum phenomenon is examined and some of the experiments establishing its validity are examined. Topics covered are: quantized behavior of superconductors, Josephson quantum-phase detector, superconducting interferometers, experiments using superconducting interferometers, and the dynamics of the macroscopic quantum system. 39 references. (M.H.R.)

27557 WEAKLY COUPLED SUPERCONDUCTORS. Josephson, B. D. (Cambridge Univ., Eng.). pp 423-48 of Superconductivity. Vols. 1 and 2. Parks, R. D. (ed.). New York, Marcel Dekker, Inc., 1969.

The ordering process in superconductors is considered in some detail. The basic theory which allows the properties of weakly coupled superconductors to be predicted falls naturally into two parts, which are described. First, a formula must be obtained to give the current flowing through the weak link. The current density at a point in the link turns out to be determined mainly by the local value of the difference between the phases of the order parameter on opposite sides of the link. This result must then be supplemented by equations giving the variations in space and time of the phase difference. The classical properties of weak links and the quantum-mechanical properties of weakly coupled superconductors are discussed. 28 references. (M.H.R.)

27558 ELECTRON–PHONON INTERACTION AND STRONG-COUPLING SUPERCONDUCTORS. Scalapino, Douglas J. (Univ. of Pennsylvania, Philadelphia). pp 449-560 of Superconductivity. Vols. 1 and 2. Parks, R. D. (ed.). New York, Marcel Dekker, Inc., 1969.

The deviations of observed properties from the BCS predictions and their relationship to the electron–phonon interaction in metals are analyzed. A theory of metals is reviewed with emphasis on the physical bases of the approximations which allow solutions to be constructed. The approximations rest upon the characteristic space–time properties of the system and the Pauli principle. This theory is applied to construct equations for the electron self-energy. Theoretical results for a number of the thermodynamic and the dynamic properties of the strong-coupling superconductors are shown to be in good agreement with the observed values. 107 references. (M.H.R.)

27559 TUNNELING AND STRONG-COUPLING SUPERCONDUCTIVITY. McMillan, W. L.; Rowell, J. M. (Bell Telephone Labs., Inc., Murray Hill, N. J.). pp 561-613 of Superconductivity. Vols. 1 and 2. Parks, R. D. (ed.). New York, Marcel Dekker, Inc., 1969.

The theory of normal metals and superconductivity is covered. The theory of the tunneling process and the experimental techniques are described. The procedures used in the solution and inversion of the gap equation and the significance of the results are discussed. 74 references. (M.H.R.)

27560 SUPERCONDUCTIVITY IN LOW-CARRIER-DENSITY SYSTEMS: DEGENERATE SEMICONDUCTORS. Cohen, Marvin L. (Univ. of California, Berkeley). pp 615-64 of Superconductivity. Vols. 1 and 2. Parks, R. D. (ed.). New York, Marcel Dekker, Inc., 1969.

Topics covered are: the BCS gap equation and its solution, kernels and results for polar and nonpolar interactions, some properties of low-carrier-density superconductors, and speculation on increasing the superconducting transition temperature of low-carrier-density superconductors. 63 references. (M.H.R.)

27561 SUPERCONDUCTIVITY IN THE TRANSITION METALS: THEORY AND EXPERIMENT. Gladstone, G.; Jensen, M. A.; Schrieffer, J. R. (Univ. of Pennsylvania, Philadelphia). pp 665-816 of Superconductivity. Vols. 1 and 2. Parks, R. D. (ed.). New York, Marcel Dekker, Inc., 1969.

The models which have been proposed for the electronic and phononic band structure of the transition metals are discussed. The concept of the rigid band model, which is found experimentally to be appropriate for these metals, is emphasized. The electron–electron and electron–phonon interactions and how they can be determined from the experimental properties of these metals in the normal state are discussed. In particular, the behavior of the electronic specific heat, the magnetic susceptibility, and the electrical resistivity are discussed. The theoretical formulation for the pairing interaction and the energy gap equation for superconductors with degenerate energy bands are presented. The variation of the pairing interaction among the transition metals, upon alloying, with changing isotopic mass and with changing atomic volume is covered. The evidence for two-band superconductors is discussed, particularly for La and U. The properties of the superconducting state are discussed, and it is shown that approximate agreement is found with the predictions of the BCS theory. 335 references. (M.H.R.)

27562 THEORY OF TYPE-II SUPERCONDUCTORS. Fetter, Alexander L. (Stanford Univ., Calif.); Hohenberg, Pierre C. pp 817-923 of Superconductivity. Vols. 1 and 2. Parks, R. D. (ed.). New York, Marcel Dekker, Inc., 1969.

Type-II behavior is discussed in its relation to the whole field of superconductivity. The theory of bulk Type-II materials is presented, based on Abrikosov's analysis of the Ginzburg–Landau equations. The specific heat in the mixed state is discussed. How flux penetration affects both the electronic density of states and the transport properties is considered. 105 references. (M.H.R.)

27563 TYPE-II SUPERCONDUCTORS: EXPERIMENTS. Serin, Bernard (Rutgers-The State Univ., New Brunswick, N. J.). pp 925-76 of Superconductivity. Vols. 1 and 2. Parks, R. D. (ed.). New York, Marcel Dekker, Inc., 1969.

Some of the concepts used in discussing the properties of type-II superconductors are outlined. The detailed properties of the vortex state and the parameters which determine the shapes of the phase boundaries are described. Major emphasis will be placed on equilibrium bulk properties, but thermal conductivity, a few dynamic effects, and some of the phenomena encountered in small systems are discussed. The current-carrying capacity of type-II superconductors or structure-sensitive properties are not covered. 114 references. (M.H.R.)

27564 BOUNDARY EFFECTS AND SMALL SPECIMENS. Burger, J. P. (Faculte des Sciences, Orsay, France); Saint-James, D. pp 977-1004 of Superconductivity. Vols. 1 and 2. Parks, R. D. (ed.). New York, Marcel Dekker, Inc., 1969.

The size-dependent properties of superconductors are investigated in the simplified case of a slab of thickness $d = 2a$ infinite in the other two directions. Since the properties of superconductors are much better understood in the "dirty limit" in which the normal electron mean free path is much smaller than the coherence length, the theory presented here is restricted to this limit. The properties described have been observed either in dirty type-II superconductors or for slabs thin enough for the influence of a finite mean free path to be included as a correction without changing deeply the conclusions obtained in the dirty limit. 46 references. (M.H.R.)

27565 PROXIMITY EFFECTS. Deutscher, G.; de Gennes, P. G. (Faculte des Sciences, Orsay, France). pp 1005-34 of Superconductivity. Vols. 1 and 2. Parks, R. D. (ed.). New York, Marcel Dekker, Inc., 1969.

Under suitable experimental conditions it appears now that reproducible results for normal–superconducting layers can be obtained on properties such as the transition temperature, the tunneling density of states, the parallel critical field, and the magnetic permeability. These results are discussed. 58 references. (M.H.R.)

27566 GAPLESS SUPERCONDUCTIVITY. Maki, Kazumi (Univ. of California, San Diego, La Jolla). pp 1035-1105 of Superconductivity. Vols. 1 and 2. Parks, R. D. (ed.). New York, Marcel Dekker, Inc., 1969.

Topics covered are: time-reversal symmetry, superconducting alloys containing magnetic impurities, thermodynamics, transport properties, superconducting films in magnetic fields, superconductors with spatially varying order parameter, and theory of a pure Type-II superconductor in the high-field region. 99 references. (M.H.R.)

27567 FLUX FLOW AND IRREVERSIBLE EFFECTS. Kim, Y. B.; Stephen, M. J. (Bell Telephone Labs., Inc., Murray Hill, N. J.). pp 1107-65 of Superconductivity. Vols. 1 and 2. Parks, R. D. (ed.). New York, Marcel Dekker, Inc., 1969.

Central to the theory of Type-II superconductors is Abrikosov's characterization of the mixed state as a lattice-like arrangement of quantized flux lines, or vortices of superelectrons. The phenomena of vortex motion and the theoretical interpretation thereof are presented in a logical order following a brief account of the historical development. Topics covered are: a local model of a vortex line, experiments on flux flow, force on vortex lines, voltages in the mixed state, flow pattern due to a single vortex line, Hall effect, thermomagnetic and galvanomagnetic effects, critical-state model, flux creep, and instabilities-flux jumps. 105 references. (M.H.R.)

27568 COMPARISON OF PROPERTIES OF SUPERCONDUCTORS AND SUPERFLUID HELIUM. Vinen, W. F. (Univ. of Birmingham, Eng.). pp 1167-1234 of Superconductivity. Vols. 1 and 2. Parks, R. D. (ed.). New York, Marcel Dekker, Inc., 1969.

The properties of superfluid helium are described briefly and the extent to which this system is understood theoretically is sketched. It turns out that the similarity between superfluid helium and a superconductor is obscured to some extent. It is useful, therefore, to consider a hypothetical system of Fermi particles (with short-range attractive interactions), which obeys the BCS theory, but in which the particles are uncharged and in which there is no background scattering. This system is described and it is shown that its properties are probably closely similar to those of superfluid helium. The comparison with real superconductors is made, and a number of specific problems, where comparison between the two systems is particularly interesting, are discussed in greater detail. 64 references. (M.H.R.)

27569 THE INTERMEDIATE STATE IN TYPE-I SUPERCONDUCTORS. Livingston, J. D.; DeSorbo, W. (General Electric Co., Schenectady, N. Y.). pp 1235-81 of Superconductivity. Vols. 1 and 2. Parks, R. D. (ed.). New York, Marcel Dekker, Inc., 1969.

Theoretical topics covered are: static equilibrium, dynamics, and transport current. Direct observations of field distribution include: techniques and history, static structures, mechanism and dynamics, effects of defects, effects of specimen shape, and effects of current. Other topics discussed are: dc magnetic properties, dc electric properties, ac properties, thermal properties, and the relation between the mixed and intermediate states. 143 references. (M.H.R.)

27570 SUPERCONDUCTING DEVICES. Newhouse, V. L. (General Electric Co., Schenectady, N. Y.). pp 1283-1342 of Superconductivity. Vols. 1 and 2. Parks, R. D. (ed.). New York, Marcel Dekker, Inc., 1969.

Work on superconducting devices published since 1964 is emphasized. Devices included are: high-field magnets, cryotrons, computer storage elements, measuring instruments, microwave devices, flux pumps, dynamos, and motors. 121 references. (M.H.R.)

27571 SUPERCONDUCTIVITY IN THE PAST AND THE FUTURE. Anderson, P. W. (Bell Telephone Labs., Inc., Murray Hill, N. J.). pp 1343-58 of Superconductivity. Vols. 1 and 2. Parks, R. D. (ed.). New York, Marcel Dekker, Inc., 1969.

Personal recollections and actual incidents of the history of the field of superconductivity are presented. The milestones and difficulties along the way to the present stage of understanding are outlined. Some speculations on future areas of research in the field are discussed. 40 references. (M.H.R.)

27572 UPPER CRITICAL FIELD OF TWO-BAND SUPERCONDUCTORS CONTAINING NONMAGNETIC IMPURITIES. II. **Chow, W. S. (Univ. of Cincinnati). Phys. Rev., 179: 444-6 (Mar. 10, 1969).**

An approximate equation is derived that is satisfied by the upper critical field of two-band superconductors containing nonmagnetic impurities at temperatures just above zero. On the basis of this equation, it is found that if both the s band and the d band are in the superconducting phase, the upper critical field is larger than that of the two-band superconductor with the d band in the superconducting phase and the s band in the normal phase, at temperatures just above zero. (auth)

27573 SUPERCONDUCTING ISOTOPE EFFECT IN MOLYBDENUM BORIDE AND TUNGSTEN BORIDE. **Englehardt, J. J. (Univ. of California, San Diego, La Jolla). Phys. Rev., 179: 452-8(Mar. 10, 1969).**

The isotope effect on the superconducting transition temperature was measured for the compounds Mo_2B and W_2B. Both the heavy masses and the B mass were varied independently in each compound. The compounds have isomorphous crystal structures with nearly identical lattice parameters. The effect of changing the boron mass appeared to be small in both compounds. The Mo and W isotope effects were much larger, and indicated either a linear or an exponential relation between transition temperature and heavy-element mass. With the approximation that the Mo_2B lattice was made up of only the Mo mass, the Mo isotope effect was found to be roughly the same as that found in elemental Mo. By considering the W isotope effect in W_2B analogously, the elemental W isotope effect is predicted to be the same as that found in nontransition-element superconductors. (auth)

27574 PRESSURE DEPENDENCE OF THE SUPERCONDUCTING TRANSITION TEMPERATURE. **Seiden, P. E. (Indiana Univ., Bloomington. IBM Watson Research Center, Yorktown Heights, N. Y.). Phys. Rev., 179: 458-62(Mar. 10, 1969).**

A theory of the superconducting transition temperature using a simple model for the electron–phonon interaction has been used to calculate the pressure dependence of the transition temperature for nontransition metals. The pressure dependence of the Debye temperature and phonon frequencies is included by using a Grueneisen model. The theory is compared to experiment for aluminum, lead, zinc, cadmium, indium, and tin, and the agreement is generally quite good. The results have been used to predict the critical pressures at which $T_c = 0$; and for the cases of zinc, cadmium, and possibly aluminum, it should be possible to carry out experiments where T_c is pushed below presently measurable temperatures. The empirical $T_c = f(P)$ relations published in the literature are discussed and compared with the present results. (auth)

72575 MEASUREMENT OF THE ELASTIC CONSTANTS AND SEARCH FOR COLLECTIVE OSCILLATIONS OF THE VORTEX LATTICE IN A TYPE-II SUPERCONDUCTOR (NIOBIUM). **Meincke, P. P. M.; Reed, W. A. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 179: 463-71(Mar. 10, 1969).**

The Abrikosov vortex lattice in a type-II superconductor should possess a shear constant and, therefore, be able to support an entirely new mode of wave propagation, as first pointed out by de Gennes and Matricon. The measurement of the compressional constant of the vortex lattice, an upper bound on the shear constant, and the attempt to observe this new mode in high-purity niobium are reported. The compressional constant D_1 is found to be 1.43×10^{-8}B dyn/vortex, where B is the magnetic field in G, and the ratio of the shear constant to the compressional constant, a, is less than 0.005. Calculations by Labusch, which are valid for finite κ with B near H_{c2}, predict values of $D_1 = 1.49 \times 10^{-8}B$ and $a = 0.0011$ for niobium, in which $\kappa_2 \simeq 2.2$ and $B \simeq 3.1$ kG at 1.37°K. The new mode was not observed. (auth)

27576 ANISOTROPY OF THE SUPERCONDUCTING ENERGY GAP IN Th. **Anderson, J. W.; Peterson, D. T.; Finnemore, D. K. (Iowa State Univ., Ames). Phys. Rev., 179: 472-4(Mar. 10, 1969).**

A value of the mean-square anisotropy constant $\langle a^2 \rangle$ for the superconducting energy gap of thorium was determined from the depression of the critical temperature as carbon impurity is added. The results indicate that $\langle a^2 \rangle = 0.021$ and that the valence effect for carbon in thorium is negligible. The effect of anisotropy on the critical-field curves of Th–Gd alloys is discussed in detail. (auth)

27577 FLUX MOTION IN TYPE-I SUPERCONDUCTORS. **Solomon, P. R. (United Aircraft Research Labs., East Hartford, Conn.). Phys. Rev., 179: 475-85(Mar. 10, 1969).**

A consistent picture of the current-carrying intermediate state of type-I slabs has been obtained from measurements of the coupled motion of flux, measurements of the Ettinghausen effect, and visual observations of diamagnetic powder replicas of the intermediate state. The electrical resistance has been shown to be due to flux flow when the average magnetic field in the sample is sufficiently small, and to Ohmic resistance of static normal domains when the field is close to H_c. In particular, flux-flow resistance occurs in the regime studied originally by Sharvin and recently by Chandrasekhar et al., and by Brandt and Parks. (auth)

27578 PHENOMENOLOGY OF SHAPE EFFECTS IN AMPERIAN MAGNETIC SYSTEMS WITH APPLICATION TO SUPERCONDUCTORS. **Cape, J. A. (North American Rockwell Corp., Thousand Oaks, Calif.). Phys. Rev., 179: 485-93(Mar. 10, 1969).**

The effects of sample shape and orientation on the magnetic properties of superconductors are discussed. The absence of adequate theoretical formulas is probably the main reason that these effects have been largely ignored in the past. The present discussion begins with the formulation of a thermodynamic potential appropriate to an Amperian system and expressed in a form adapted to the Landau theory of phase transitions. The shape dependence is expressed explicitly in terms of the usual demagnetization factors, and the dependence on H_0 and T (the applied magnetic field and temperature) is expressed implicitly through the magnetization which is defined uniquely and self-consistently in terms of the currents and the magnetic moment. The formulation finds a natural application in the description of superconductors and leads to a vector generalization of Abrikosov's constitutive relation for the superconducting mixed state. Explicit formulas are derived for the magnetic moment per unit volume, specific heat, force, and torque for the Meissner state and mixed state of a spheroid of arbitrary shape and orientation in an applied field. It is found that the sample shape is always important for the Meissner state, and is important for the mixed state whenever the inequality $(2\kappa^2-1)\beta \gg 1$ is not satisfied. Here κ is the Ginzburg–Landau parameter, and β is expected to have the value 1.16 for fluxoid lattices carrying a single flux quantum per unit cell. (auth)

27579 NONLINEAR EFFECTS ON THE CONDUCTIVITY OF A SUPERCONDUCTOR ABOVE ITS TRANSITION TEMPERATURE. Hurault, J. P. (Univ. of California, Los Angles). Phys. Rev., 179: 494-6(Mar. 10, 1969).

The conductivity σ of a metal was studied for temperatures slightly greater than its transition temperature T_c. In this region, the conductivity can reach very high values, because of the fluctuations of the order parameter. But, as the electric field is increased, the velocity of the accelerated electrons increases, the lifetime of the fluctuations decreases, and the conductivity decreases. For sufficiently high fields, the conductivity is thus found to vary as $E^{(\nu-4)/2}$, ν being the dimension of the sample. (auth)

27580 CRITICAL MAGNETIC FIELDS OF SUPERCONDUCTING SnTe. Hein, R. A. (Naval Research Lab., Washington, D. C.); Meijer, P. H. E. Phys. Rev., 497-511(Mar. 10, 1969).

Upper critical magnetic fields $H_{c2}(T)$ of five samples of superconducting SnTe possessing different values of the nominal carrier concentration P* were measured as a function of the temperature. Lower critical field data $H_{c1}(T)$ were also obtained on four of these samples. Values of P* vary from a low of 7.5×10^{20} per cm^3 to a high of 20.0×10^{20} per cm^3. The superconducting transition temperatures T_0 increase with increasing P* from a low of 0.034°K to a high of 0.214°K. Values for $H_{c2}(T)$ were obtained from the magnetic field dependence of both ac and dc magnetic susceptibility data. Values for $H_{c1}(T)$ were obtained from measurements of the magnetic moment as a function of magnetic field. The observed values of $H_{c1}(T)$ were rather small, being of the order of 10^{-1} Oe. Application of the Ginsburg–Landau–Abrikosov–Gor'kov (GLAG) formulas to the critical magnetic field data allows one to calculate values for the Ginsburg–Landau parameter κ. Values of κ are found to increase with increasing values of P* and range from a low of 3.9 to a high of 6.1. Application of the Goodman–Gor'kov equation to the normal-state parameters of this material lead to values which are about 25% higher than the above values. The agreement between the observed T_0's and the theoretical predictions of Allen and Cohen is reasonably good. (auth)

27581 MATHEMATICAL METHODS IN SOLID-STATE AND SUPERFLUID THEORY. Clark, R. C.; Derrick, G. H. (eds.). Edinburgh, Oliver and Boyd, 1969. 416p. 147s.

Lectures and research seminars presented at the Scottish Universities' Summer School in Physics, 1967, are reproduced. Topics include: variational principles, transformation theory, microscopic description of superfluidity, transport theory, density matrix methods and superconductivity theory, quantum statistical mechanics by perturbation resummation methods, perturbation theory and its applications, exactly soluble models (Heisenberg chain, two-dimensional Ising model, ice model, KDP and F models), effective long-range order and phase transitions in one-dimensional systems, particle-hole excitations and self energy of quasi-particles in a Fermi liquid, renormalized theory of low temperature specific heat of liquid ^3He, phonon-phonon interaction and second sound in dielectrics, asymptotic behavior of correlation functions in classical and quantal fluids, variational principles in quantum statistical mechanics, and rigorous lower bounds on paramagnetic susceptibility. (UK)

27582 PEAK EFFECTS OF CRITICAL CURRENT DENSITIES IN TYPE II SUPERCONDUCTORS. Kobayashi, Yukoh; Yamufuji, Kaoru (Yamaguchi Univ., Japan). Kyushu Daigaku Kogaku Shuho, 41: 850-4(Oct. 1968). (In Japanese).

In type-II superconductors, the critical current density usually decreases monotonously with the external magnetic field. But in certain specimens, the curve shows a peak value, close to a critical magnetic field—the peak effect of a critical current density. In the study performed, the theory of phenomena with regard to the flow of magnetic flux was expanded so as to include the hole flow, and a theoretical formula was derived for the peak effect. The formula was found to agree well with the results of experiment. The changes of parameters in the formula, by temperature and heat treatment, were also studied. How accurately these parameters are determined, is also described. (NSA of Japan)

27583 SURFACE TENSION OF DILUTE ^3He AND ^4He SOLUTIONS. Zinov'eva, K. N.; Boldarev, S. T. Zh. Eksp. Teor. Fiz., 56: 1089-99(Apr. 1969). (In Russian).

The surface tension coefficient α of an $^3He-^4He$ solution was measured on the basis of the rise of the liquid in a capillary. The measurements were carried out between 0.4 and 2.0°K for six concentrations of the mixture c (10^{-4}, 1.2×10^{-3}, 5.6×10^{-3}, 5.2×10^{-2}, 9.6×10^{-2} and 2.2×10^{-1}). For all mixtures (excepting $c = 10^{-4}$) a maximum was observed on the $\alpha(T)$ curve. The results support the assumption of Andreev regarding the existence of a new type of excitation with a dispersion law $E = \Delta - \epsilon_0 + k^2/2\mu$ near the boundary of the liquid $^3He-^4He$ mixture. The parameters of the spectrum are determined and are $\epsilon_0 = 1.7 \pm 0.2°K$, $\mu = (0.9 \pm 0.1)\underline{M}$, where Δ and $\underline{M}$ are, respectively, the minimal energy and the effective mass of the admixture excitations in the liquid. (auth)

27584 SUPERCONDUCTING ALLOYS IN A STRONG ALTERNATING FIELD. Gor'kov, L. P.; Eliashberg, G. M. Zh. Eksp. Teor. Fiz., 56: 1297-1308(Apr. 1969). (In Russian).

The dynamic properties of the parameter Δ for superconducting alloys are investigated in the vicinity of the transition temperature T_c. It is shown that the transition to the adiabatic pattern occurs only at anomalously low frequencies. The corresponding characteristic frequency Ω_0 for a massive superconductor is of the order of Δ^3/T_c^2, and for small size superconductors it depends on inelastic processes (electron–electron and electron–phonon interactions). The expression for the current density goes over to the static formula for frequencies $\omega < \Omega_1 \sim \Delta^2/T_c$. The dependence of Δ on the amplitude of the applied alternating field is nonunique at the superconductor boundary for intermediate frequencies $\Omega_0 < \omega < \Omega_1$. This corresponds to the instability of the regime in a certain amplitude range. (auth)

27585 ANISOTROPY OF THE SURFACE SUPERCONDUCTIVITY CRITICAL CURRENT NEAR A FIELD STRENGTH H_{c3}. Rusinov, A. I. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz., 56: 1441-7(Apr. 1969). (In Russian).

The problem of surface superconductivity in a state with a nonvanishing total current for $H - H_{c3} \ll H_{c3}$ is solved with the aid of the Ginzburg–Landau equations. The maximal value of the critical current in a direction perpendicular to the magnetic field (which is in the plane of the sample) is 20% smaller than the value for the longitudinal direction. This is in agreement with the results of a numerical calculation. (auth)

27586 STABILIZING THE SUPERCONDUCTOR. Barber, A. C. Copper (London), 2: No. 6, 2-4(Nov. 1968).

The degradation of high-field superconductors such as Nb_3Sn and Nb–25% Zr in tape and wire form is caused by changes in magnetic flux distribution when the coil is being charged. A result of a flux jump is total heating which can bring about a reversion to the normal conductive state. The effect can be reduced by including a Cu conductor in close contact with the superconductor. (Metals Abstr.)

27587 RESISTANCE OF TANTALUM IN THE INTERMEDIATE (SUPERCONDUCTING–NORMAL) STATE. Smith, Frank T. J.; Gatos, Harry C. (Massachusetts Inst. of Tech., Cambridge). J. Appl. Phys., 40: 2232-7(Apr. 1969).

Tantalum may be converted from a type I to a type II superconductor when small amounts of interstitial impurities are present. The resistance of type I and type II wire specimens was measured in a transverse magnetic field during the superconducting to normal transition. It was found that for both types carrying a transport current, the resistance for the major portion of the transition region is a function of the Lorentz force acting on the normal domains of the intermediate state or on the flux filaments of the mixed state. The effects of strain and impurity were also studied and were interpreted in terms of their influence in retarding the motion or pinning of normal domains in the material. (auth)

27588 PRINCIPLES OF STABILITY IN COOLED SUPERCONDUCTING MAGNETS. Stekly, Z. J. J.; Thome, R.; Strauss, B. (Avco Everett Research Lab., Everett, Mass.). J. Appl. Phys., 40: 2238-45(Apr. 1969).

The equations for the terminal characteristics of a composite superconductor are formulated taking into account heat transfer to a coolant, interface thermal contact resistance, and the size of the superconductor itself. The nonlinear heat-transfer characteristics of liquid helium are also taken into account in an approximate manner. The general relationship for stability is derived in terms of dimensionless parameters involving the size and characteristics of the substrate and the superconductor and the heat-transfer coefficients at the interfaces between the superconductor and the substrate, and between the substrate and the coolant. It is also concluded that if the superconducting strands are smaller than a characteristic size, one would expect that flux jumps should disappear. (auth)

27589 OPTIMUM SHAPES FOR SUPERCONDUCTING SOLENOIDS. Atherton, David (Ferranti-Packard Electric Ltd., Toronto). J. Appl. Phys., 40: 2246-7(Apr. 1969).

A technique is described for determining optimum, minimum volume shapes for uniform current density superconducting solenoids. The calculations include the effects of the dependence of current density upon the peak field at the coil winding and lead to coils which are significantly longer than those predicted by previous, field-independent optimization techniques. (auth)

27590 FLUX MOTION, ELECTRICAL RESISTANCE, AND NOISE IN SUPERCONDUCTORS. Park, J. G. (Imperial Coll. of Science and Tech., London). J. Phys., C (London), 2: 742-51 (Apr. 1969).

The basic physics of the processes producing flux flow resistance in superconductors is reconsidered. It is shown that in the dynamic intermediate state (in which at low fields flux tubes move through the material) there is no potential difference between the contracts; the measured voltage is produced by magnetic flux outside the superconductor which changes as each of the tubes moves. On the other hand, in a type-II superconductor near H_{c2} there is a potential difference between the contacts and no effect of changing magnetic flux. It is conjectured that, in general, in the mixed state there are contributions of both types to the measured voltage V, the fraction V_p/V produced by a potential difference in the superconductor decreasing as the field is lowered below H_{c2}. In all cases the measured voltage V is the same as if there were an electric field $(v \times B)/c$ in the superconductor, where v is the average velocity of the flux "entities" and B the flux density in the material. The low-frequency noise in superconductors corresponds to fluctuations in the component of voltage V_i produced by magnetic flux changes. This has the consequence that the noise spectrum should depend on the arrangement of the leads of the measuring circuit, and also that the decrease in noise observed with increasing field in the mixed state corresponds to the decrease in the ratio V_i/V and does not necessarily represent a decrease in the size of the flux "entities" with increasing field. (auth) (UK)

27591 LATTICE THERMAL CONDUCTIVITY OF Ta-Nb AND Nb-Mo SOLID SOLUTION ALLOYS IN NORMAL AND SUPERCONDUCTING STATES. Sousa, J. B. (Clarendon Lab., Oxford). J. Phys., C (London), 2: 629-39(Apr. 1969).

A detailed experimental investigation on the validity of the Bardeen–Rickayzen–Tewordt (BRT) theory for the ratio of the lattice thermal conductivity in the normal and superconducting states was made for Nb–Mo and Nb–Ta alloys over a wide range of composition. The measured lattice ratios for the nine samples investigated were in complete agreement with the BRT theory down to reduced temperatures $t \sim 0.4$. Below this temperature agreement was still obtained for the thicker samples; in thin samples deviations appeared which are attributable to boundary or dislocation scattering. The variation of the lattice conductivity with composition was also investigated. Addition of Mo to Nb noticeably increased the lattice conductivity, whereas addition of Ta to Nb had a much smaller effect. These results can be explained in terms of the variation of the electronic density of states N(0) with composition. (auth) (UK)

27592 SUPERCONDUCTING TUNNELING IN METAL/SEMICONDUCTOR JUNCTIONS. Tsuda, Nobuo (Tokyo Univ.). Jap. J. Appl. Phys., 8: 582-7(May 1969).

Superconducting tunneling effects were observed for mechanically contacted Nb/Si, Pb/Si, and Nb/GaAs junctions. The I–V curves of Nb/Si junctions largely deviate from the usual BCS curve. Deviations for Nb/GaAs and Pb/Si junctions are much smaller than that for a Nb/Si junction. This large deviation is explained by the uniformly distributed surface states on the boundary. The upper critical field H_{c2} and H_{c3} of the junctions are much larger than those of bulk niobium. (auth)

27593 COMMENTS ON THEORY OF SUPERCONDUCTORS WITH OVERLAPPING BANDS IN THE PRESENCE OF NONMAGNETIC IMPURITIES. Chow, W. S. (Univ. of Cincinnati). Phys. Rev., 180: 631(Apr. 10, 1969).

It is shown that in the intraband phonon-coupling limit, the s–d interband impurity scattering leads to the decrease of the d-band transition temperature if $\overline{\Delta}_d > \overline{\Delta}_s$. (M.H.R.)

27594 DIAMAGNETIC SUSCEPTIBILITY AT THE TRANSITION TO THE SUPERCONDUCTING STATE. Schmid, Albert (Stevens Inst. of Tech., Hoboken, N. J.). Phys. Rev., 180: 527-9(Apr. 10, 1969).

Fluctuating Cooper pairs contribute to the diamagnetic susceptibility in a superconductor above the critical temperature. The effect is the greatest in a clean metal where the extra susceptibility is about $10^{-7} \times [T_c/(T - T_c)]^{1/2}$ in a bulk sample (auth)

27595 PRESSURE EFFECTS ON THE SUPERCONDUCTING TRANSITION TEMPERATURE OF Pb. Hodder, Robert E. (United Aircraft Research Labs., East Hartford, Conn.). Phys. Rev., 180: 530-4(Apr. 10, 1969).

McMillan's theory of the transition temperature of strong-coupling superconductors is extended to allow calculation of pressure effects on T_c from measured shifts in the transverse and longitudinal peaks in the phonon density of states. Using multiple-cutoff Lorentzians as a model for the phonon spectrum, it is shown that the pressure dependence of α_ν^2, the square of the electron-phonon coupling strength for the phonon mode ν, can be expressed largely in terms of pressure-induced shifts in the phonon peaks and that the remaining dependence can be calculated using pseudopotential theory. The results are evaluated for Pb using pressure data from two different electron-tunneling studies. When the data of Franck and Keeler are applied to the theory, the results are in good agreement with experiment. However, data from the work of Zavaritskii et al. yield a value of the pressure dependence of T_c which differs by more than a factor of 2 from that found experimentally. In addition to these results, the pseudopotential calculation was used to evaluate α_ν^2 and find for Pb $\alpha_t^2 =$ 1.28 MeV and $\alpha_l^2 = 1.36$ MeV. These values compare favorably to $\alpha_t^2 = 1.11$ MeV and $\alpha_l^2 = 1.34$ MeV which have been calculated directly from tunneling data by McMillan and Rowell. (auth)

27596 SOFT-MODE SUPERCONDUCTIVITY IN $SrTiO_{3-x}$. Appel, J. (Gulf General Atomic Inc., San Diego, Calif.). Phys. Rev., 180: 508-16(Apr. 10, 1969).

The transition temperature T_c of $SrTiO_{3-x}$ is calculated as a function of the electron concentration. The effective electron–electron interaction has an attractive part caused by the intravalley exchange of soft optical phonons that have been observed in the tetragonal phase with Raman scattering and neutron diffraction. The Coulomb part is determined by the longitudinal dielectric constant for a degenerate polar semiconductor. The deformation potential for the interaction between electrons and soft phonons of symmetry A_{1g} is used as an adjustable parameter to fit T_c at one experimental point. (auth)

27597 EVIDENCE FOR QUASIBOUND STATES IN A KONDO SUPERCONDUCTOR. Edelstein, Alan S. (IBM Watson Research Center, Yorktown Heights, N. Y.). Phys. Rev., 180: 505-7(Apr. 10, 1969).

Contrary to the predictions of the Abrikosov–Gor'kov theory, it is found that a Kondo superconductor (Ce in La) is gapless even at very low concentrations and temperatures. At low impurity (Ce) concentrations in La, the number of states in the gap as determined from electron tunneling measurements is proportional to the Ce concentration. These states are likely to be quasibound states which result from electron scattering from the impurities. (auth)

27598 ELECTRON TUNNELING IN SUPERCONDUCTING $Cd/Al_2O_3/Al$ JUNCTIONS. Kumbhare, Prabha; Tedrow, P. M.; Lee, D. M. (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 180: 519-26(Apr. 10, 1969).

Studies were performed of the superconducting tunneling characteristics of $Cd/Al_2O_3/Al$ junctions. The superconducting energy gap $2\Delta_{Cd}(0)$ was found to be 0.130 mV. Its variation with temperature was studied and has been compared with the predictions of the BCS theory. Measurements were also made in the presence of magnetic fields, and an effort was made to compare measurements with Ginzburg–Landau theory. Extra structure in the first derivative of the tunneling characteristics (dV/dI versus V) was observed, and experiments were undertaken to ascertain whether this structure was caused by edge effects in the films or was a more basic feature of the films. (auth)

27599 ON THE THEORY OF THE ENERGY SPECTRUM OF ^3He DILUTED MIXTURES IN SUPERFLUID ^4He. Slyusarev, V. A.; Strzhemechnyi, M. A. (Kharkov Inst. for Low Temperature Physics and Tech.). Ukr. Fiz. Zh., 14: 453-60(Mar. 1969). (In Russian).

A variational method was applied to the problem of the excitation spectrum of a ^{3}He impurity quasi particle in superfluid ^{4}He. The energy of effective interaction between the quasi particles is found. The results and conclusions of the theory are compared with those obtained by means of quantum-hydrodynamical considerations. (auth)

Plasma and Thermonuclear Physics

27600 (MATT-Q-26) ANNUAL REPORT COVERING THE PERIOD JANUARY 1–DECEMBER 31, 1968. (Princeton Univ., N. J. Plasma Physics Lab.). Mar. 1969. Contract AT(30-1)-1238. 267p. Dep. CFSTI.

Separate abstracts were prepared for the three separate sections. (M.O.W.)

For abstracts of individual sections see: 27603, 27627, and 27652.

27601 PLASMA PHYSICS INDEX. EXPERIMENTAL AND THEORETICAL PLASMA PHYSICS. Volume 3, No. 12, 1968. Hilsenbeck, D. (comp.). AED Bibliographien zur Kernforschung und Kerntechnik. Frankfurt am Main, Zentralstelle fuer Atomkernenergie-Dokumentation, 1968. 230p. DM 96,-. (AED-C-3-27).

Four-hundred twenty-five articles on various aspects of plasma physics are listed. Subject and author indexes are included. (M.O.W.)

Confinement and Heating

Refer also to abstract 27644.

27602 (AWRE-O-2/69) ELECTRIC FIELDS IN FLUX COMPRESSION DEVICES. Speight, C. S. (Atomic Weapons Research Establishment, Aldermaston (England)). Feb. 1969. 39p. Dep. CFSTI. UK 5s. 6d.

A model of the electromagnetic field is presented, and application of the model to study the electric fields that arise during the process of flux compression, in such a way as to minimize the risk of breakdown in the design stage, is discussed. (UK)

27603 (MATT-Q-26, pp 1-141) EXPERIMENTAL WORK. (Princeton Univ., N. J. Plasma Physics Lab.).

ARGON—plasma of oscillations in spherator, (E)
BARIUM—plasma of, resonance line excitation in Q device, (E/T)
—plasma of, effects of collisional drift waves on density in, (E)
ELECTRON BEAMS—use for analysis of confining magnetic field of C stellarator, (E)
HELIUM—plasma of, collisional transition rates and recombination in, (E)
—plasma of, electron temperatures from He(I) intensity measurements, (E)
HYDROGEN—plasma of oscillations in spherator, (E)
MICROWAVES—scattering on electron plasma wave instability, (E/T)
PLASMA—heating in spherator, electron cyclotron resonance, (E)
—oscillations in spherator, argon and hydrogen, (E)
—confinement and losses in LM-1 and spherator devices, (E)
—wave excitation in C stellarator, ion cyclotron, (E/T)
—heating in nonuniform magnetic fields, use of Stix coil for ion cyclotron resonance, (E)
—heating in Etude device, ion temperatures in, (E/T)
—confinement in Q devices, end losses in, (E)
—waves in, critical fluctuations and growth rates associated with collisional drift, (E/T)
—wave in Q device, soft and hard onset of collisional drift, (E/T)
—collisions in Q devices, barium resonance line excitation in, (E/T)
—collisions in barium, effects on density of, (E)
—wave interactions with electron wave instability, electromagnetic (E/T)
—wave echoes in, spatial and temporal cyclotron harmonic, (E)
—collisions in helium, transition rates and recombination in, (E)
—diagnostics of helium, electron temperature from He(I) intensity measurements, (E)
Q DEVICES—plasma and losses in, (E)
—plasma waves in, soft and hard onset of collisional drift, (E/T)
STELLARATORS—plasma confinement and losses in spherator, microwave-produced, (E)
—plasma electron cyclotron resonance heating in spherator, (E)
—plasma oscillations in spherator, argon and hydrogen, (E)
—magnetic field calculations for spherator, errors in, (T)
STELLARATORS (A-2)—plasma heating in Etude, ion temperature in, (E/T)
STELLARATORS (C)—magnetic field analysis using low-energy electron beams, (E)
—ion cyclotron wave excitation at low densities in, (E/T)
THERMONUCLEAR REACTORS—plasma confinement and losses in LM-1 and spherator devices, (E) (M.O.W.)

27604 INFLUENCE OF THE SHAPE AND MAGNITUDE OF THE DISCHARGE CURRENT PULSE ON PLASMA CONTAINMENT AND HEATING IN TOKAMAK-3. Mirnov, S. V. (Kurchatov Inst. of Atomic Energy, Moscow). Nucl. Fusion, 9: 57-66 (Mar. 1969).

Measurements were made of plasma energy and energy replacement time as a function of the shape and magnitude of the discharge current pulse. It has already been established that the maximum transverse energies $E_\perp$ and energy replacement times τ_E in Tokamak-3 are reached 2 to 3 ms after the peak of the discharge current I. The author shows how $E_\perp(t)$ and $\tau_E(t)$ depend on the shape of the discharge current pulse and the duration of the discharge. An attempt is made to connect the observed relationships with the current density distribution. The internal (l_i) and external $(L_{ext} = 2 \ln (b/a))$ self-inductance coefficients of the plasma column are measured and, on the basis of the results, an estimate is obtained of the shear averaged over the radius a. Hypotheses are advanced regarding the nature of the processes which determine the observed patterns of behavior. One possible explanation is the presence of either dissipative helical instability (tearing mode) or overheat instability in the initial stage of the discharge and during the current rise. (auth)

27605 FUSION RESEARCH IN OPEN-ENDED SYSTEMS. Fowler, T. K. (ed.). Nucl. Fusion, 9: 3-18(Mar. 1969).

Low-beta fusion research in open-ended magnetic geometries (mirrors) is reviewed. This material, extracted from the report of a USAEC panel convened to examine mirror research, has been edited and revised to include recent information. It is intended to present an overview of the achievements, methods, and rationale of this area of fusion research. Topics covered include the scope of mirror research, classical end losses, and fusion economics, minimum-B stabilization of flute instability, theoretical and experimental results concerning loss-cone instabilities, and a summary of experiments and experimental techniques. (auth)

27606 TURBULENT DIFFUSION AND ION HEATING DURING CURRENT INSTABILITY. Buchel'nikova, N. S.; Salimov, R. A. (Inst. of Nuclear Physics, Novosibirsk, USSR). Zh. Eksp. Teor. Fiz., 56: 1108-19(Apr. 1969). (In Russian).

The development of turbulency and the state of a plasma in the case of a developed current instability are investigated. It is shown that anomalous transverse diffusion is due to turbulent oscillations. It is found that excitation of instability is accompanied by heating of the ions. (auth)

27607 ENHANCED PLASMA HEATING IN LASER-INDUCED GAS BREAKDOWN AT THE SHOCK FRONT OF A BLAST WAVE. Ahmad, N.; Key, M. H. (Queen's Univ., Belfast). Appl. Phys. Lett., 14: 243-5(Apr. 15, 1969).

A technique is described for limiting the axial propagation of the absorption zone in laser-induced gas breakdown. A theoretical model suggests that the resulting localized energy deposition should allow heating of the plasma to temperatures comparable with those obtained when a focused laser beam heats small particles in vacuum. Preliminary experimental results confirm the localization of the absorption zone. (auth)

Diagnostics

27608 (AEC-tr-7012) CONCERNING THE POSSIBILITY OF APPLICATION MICROWAVE FIELDS FOR THE STABILIZATION OF CONVECTIVE INSTABILITY OF PLASMA. Glagolev, V. M.; Khromkov, I. N.; Cheverev, N. S. (Akademiya Nauk SSSR, Moscow. Institut Atomnoi Energii). Translated from report IAE-1490. 64p. (In English and Russian). Dep. CFSTI.

The interaction of resonant-cavity uhf fields ($\omega \sim 2 \times 10^{10}$ sec^{-1}) with plasma ($n = 10^{13}$ to 10^{14} cm^{-3}) in a constant magnetic field was investigated. Paramagnetic currents arise in the plasma out to the surfaces as a result of the uhf field; the effect on increase of the static magnetic field inside the plasma agrees with estimates. For

$\omega_H/\omega = 0.5$, electron parametric resonance was shown, leading to a sharp increase of plasma pressure, $p_0 \sim \beta_0 = 8\pi p_0/H_0^2 \simeq 0.2$. The possibilities of using the paramagnetic effect for stabilization of convective instabilities in different plasma systems are discussed. (tr-auth)

27609 (N–69-15308) BOUNDARY CORRECTIONS FOR A COAXIAL THREE-COIL CONDUCTIVITY–VELOCITY PLASMA PROBE. Final Report. Kinra, Vikram K. (Utah State Univ., Logan). 1968. 79p. (NASA-CR–99006). CFSTI.
Thesis.

Several configurations of immersible three-coil devices have been proposed that measure local values of electric conductivity and velocity in unbounded conducting fluids at low magnetic Reynolds numbers. Using a previously tested configuration of three coils mounted on separate support rods, the theory was extended to account for the presence of a finite cylindrical boundary. The work described here was concerned with an improved probe that further decreases the flow perturbation effects of the previous design by mounting the three coils on a single support rod. Cylindrical boundary correction factors are computed and compared with experimental data taken in cylinders of quiescent electrolyte. The results are found to agree within 10%. (auth) (STAR)

27610 (N–69-15312) DIAGNOSTICS OF ACCELERATING PLASMA. Semiannual Progress Report, March 1–August 31, 1968. Lie, T. N.; Lee, K. F.; McLean, E. A. (Catholic Univ. of America, Washington, D. C. Dept. of Space Science and Applied Physics). Dec. 1, 1968. 45p. (NASA-CR–99042; SAPR–5). CFSTI.

Electron temperatures and densities behind the incident and reflected shock front in the T-type electromagnetic shock tube were determined using the laser light scattering method. Since this method only depends on the assumption of the Maxwellian velocity distribution of the plasma particles, the electron temperatures thus obtained are independent of the local thermal equilibrium (LTE) assumption in the plasma. The laser scattering temperatures are then compared with the spectroscopic temperature, which depends on LTE condition. It was found that the two temperatures agree well within the experimental uncertainty, indicating that the LTE assumption in the spectroscopic temperature determination is a reasonable approximation. As a preliminary study for the coaxial plasma accelerator, the stability of a plasma having two components of different drift velocities and temperatures and bounded by a conducting cylinder was investigated. In conjunction with the geometrical parameters given earlier, the derived formulas for velocity thresholds, maximum wave number, and number of unstable modes in a system can be applied to streaming instabilities under a variety of conditions. It is seen that the instability depends sensitively on both the geometry and the temperature ratio of the two components. (auth) (STAR)

27611 (N–69-15764) NEAR-SURFACE ELECTRON TEMPERATURE OF WEAKLY IONIZED PLASMA ACCORDING TO KINETIC THEORY. Chung, Paul M. (Illinois Univ., Chicago). Nov. 1968. 44p. (NASA-CR–99047). CFSTI.

Properties of electrons near absorbing and emitting surfaces were studied for weakly ionized plasma by analyzing the Boltzmann equation governing the electrons. For simplicity, it was assumed that the electric field intensity is given a priori. It was shown that there exists a nonequilibrium absorption layer, near the surface, wherein the kinetic distribution of electrons is completely out of equilibrium for all values of the mean free path, when the surface is highly absorbent with small or no electron emission. This layer is responsible for the large electron temperature jump at the surface, and it governs the electron temperature profile through the continuum as well as the rarefied plasmas. It was found from the analysis that the simple surface boundary condition for the continuum electron energy equation previously employed by the author is correct when there is no surface emission. Similar simple surface boundary conditions are deduced for surfaces with given finite emission rates. (auth) (STAR)

27612 PLASMA DENSITY MEASUREMENT BY ION-BEAM PROBING. Jobes, F. C.; Marshall, J. F.; Hickok, R. L. (Mobil Research and Development Corp., Princeton, N. J.). Contract F44620-67-C-0043. Phys. Rev. Lett., 22: 1042-5(May 19, 1969).

The collisional dissociation of a beam of energetic H_2^+ ions provides a localized and rapid measurement of plasma density and perturbation of plasma density, yet leaves the plasma undisturbed. (auth)

27613 OBSERVATIONS ON THE REFLECTED SHOCK IN A T TUBE AND COMPARISON WITH THEORY. Dangor, A. E.; Chowdhury, S. S. (Imperial Coll. of Science and Tech., London). J. Quant. Spectrosc. Radiative Transfer, 9: 705-11(May 1969).

The temperature and electron number density behind the reflected shock in helium gas in a T tube were measured over a wide range of shock conditions. These parameters are compared with theoretical values obtained from the equilibrium solution of the conservation shock equations. Over the range of filling pressures examined (0.1 to 10 mm Hg), a maximum discrepancy of 40% in temperature was observed between theory and experiment. The curve of electron number density in the reflected shock against filling pressure showed a maximum. A similar effect was observed by Burgess et al. in measurements on z-pinch discharges. The effect is explained in terms of shock theory. (auth) (UK)

27614 INVESTIGATION OF AN MPD PLASMA JET BY GASDYNAMIC EXPERIMENTAL METHODS. Krause, S. (Deutsche Versuchsanstalt fuer Luft-und Raumfahrt eV, Stuttgart). AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 7: 554-6 (Mar. 1969).

Swirl, entrainment, and pressure distribution within an MPD plasma jet as determined from theoretical and experimental studies are briefly discussed. Probes were used in the analysis. (M.O.W.)

27615 DETERMINATION OF TEMPERATURE AND ELECTRON DENSITY IN A PLASMA RADIATION BEAM USING A SPECTROGRAPH OF LOW DISPERSION. Franke, Hermann; von Trzebiatowski, Adolf. Wiss. Ber. AEG-Telefunken, 41: 72-5(1968). (In German).

In order to examine accurately the plasma beams occurring in high-current arc discharges, particularly the temperature and the charge-carrier densities must be determined in addition to other physical values. As far as possible these values must be determined as parameters as a function of the plase of the ac arc producing the plasma beam, and of the point in the plasma beam. Spectroscopy—a nonfeedback measuring method which appears highly suitable for the purpose—yields the desired information from the analysis of the light emitted by the plasma beam in accordance with evaluation methods whose fundamentals have been familiar for a long time and which have been considerably improved during recent years. Different methods and their characteristics are described. (auth)

Kinetics (General)

Refer also to abstract 27603.

27616 (AD–677463) MAGNETICALLY INDUCED CURRENTS AND THERMOELECTRIC EFFECTS IN A NONUNIFORM PLASMA STREAM. Technical Report. Dove, William F. (California Univ., Berkeley. Div. of Aeronautical Sciences). Aug. 1968. Contract Nonr-222(45). 187p. (AS–68-5). CFSTI.

An experimental and theoretical investigation into the definition and effects of magnetically induced currents in a nonuniform, decaying, partially-ionized gas flow is reported. It is shown that it is possible to explain certain experimental observations if thermoelectric charge transport is included in the constitutive relation between fields and current density. In addition, (1) measured values of the ratio of an effective electron thermal conductivity to the thermoelectric coefficient and (2) experimental conditions suggest that this partially-ionized-gas transport can be adequately explained in terms of the results of fully ionized-gas transport theory (Spitzer–Haerm). Implicit in this result is the conclusion that the total emf induced in nonuniform ionized gases includes a direct contribution from the electron energy in addition to the well-known motional emf which derives from the relative motion of conductor and induction field. (auth) (USGRDR)

27617 (N–69-10968) MICROWAVE DEVICE INVESTIGATIONS. Semiannual Progress Report, April 1–October 1, 1968. Getty, W. D.; Haddad, G. I.; Lomax, R. J.; Rowe, J. E. (Michigan Univ., Ann Arbor. Electron Physics Lab.). Oct. 1968. 16p. (NASA-CR–97744; SAPR–4). CFSTI.

Reported are continuing studies of beam–plasma interactions; cyclotron harmonic instabilities; harmonic generation in a beam–plasma system; paramagnetic materials for millimeter and submillimeter wave detection; and bulk semiconductor materials for millimeter and submillimeter wave detectors. Experiments on development of a relativistic electron beam device for millimeter wave generation were discontinued because of the following inherent problems: (1) poor beam transmission due to thermal effects; (2) alignment problems with various components; and (3) high-voltage breakdown. (STAR)

27618 (N–69-12544) DISCHARGE CHAMBER STUDIES FOR MERCURY BOMBARDMENT ION THRUSTERS. Final Report. Knauer, W.; Poeschel, R. L.; King, H. J.; Ward, J. W. (Hughes Research Labs., Malibu, Calif.). Sept. 1968. Contract NAS3-9703. 137p. (NASA-CR–72440). CFSTI.

Parameter studies, discharge diagnostics and theory, and efforts concerned with optimizing the performance of Kaufman thrusters are summarized. A study of properties of the hollow-cathode plasma and interaction of this plasma with the discharge plasma led to understanding and prevention of hollow-cathode-tip sputtering and decoupling between hollow-cathode and discharge plasmas. Design rules for high-performance thrusters were postulated, based upon an understanding of the thruster discharge mechanism. A thruster optimization effort was conducted with two 15-cm-diameter thrusters that used electromagnets and operated without neutralizers. Using the design rules, an optimized cathode, and a hollow cathode, thruster configurations were formulated and built and their performance characteristics determined. (STAR)

27619 (N–69-18041) AN EXPERIMENTAL AND THEORETICAL ANALYSIS OF THE CONVECTED BALANCED ARC. Nicolai, Leland Malcolm (Michigan Univ., Ann Arbor). Feb. 1969. 194p. (NASA-CR–1267). CFSTI.

Thesis.

The behavior of dc electric arcs in cross-flow and transverse magnetic fields was studied by observing interaction and energy-exchange processes between the arc, the velocity field, and the magnetic field. Experiments with high-current arcs immersed in supersonic airstreams proved that with cone cylinder electrodes the arc always slanted with the anode spot upstream of the cathode spot. The peak temperature was located forward of the arc axis. Slant angle at constant Mach number increased slightly with increasing current. A theoretical continuum fluid model was formed based on the experimental observation that the convected balanced arc is impervious to free stream. Analysis of the arc core, based upon this model, showed that one-dimensional equations gave a satisfactory approximation for the temperature distribution along the x axis; as the Joule heating-term coefficient decreased to its constant value, the calculated peak temperature shifted to a more forward position and finally distorted around the periphery of the front half of the arc. (STAR)

27620 ONDES DANS LES PLASMAS. PHYSIQUE SPATIALE. (Waves in Plasmas. Space Physics). Quemada, Daniel. Collection de Physique du Centre National d'Etudes Spatiale. (Physics Collection of the National Center for Space Studies). Paris, Herman, 1968. 283p.

A book written for students beginning their study of plasma physics is presented. Plasmas and the conditions for their existence are defined. The bases of the linear dielectric description of plasmas in terms of the $\epsilon_{\alpha\beta}$ components of the dielectric tensor ϵ are reviewed. The approximation of cold plasmas is given for homogeneous infinite plasmas. The modifications caused by the presence of limits are analyzed. The problems connected with the propagation of energy are summarized. The longitudinal oscillations, particularly Landau damping, are studied. The case of magnetoplasmas is considered, showing cyclotron damping. Energy transfer in hot plasmas is analyzed in the framework of the dielectric description. The principal effects on the characteristics of the high-frequency modes in cold plasmas are summarized. (J.S.R.)

Kinetics (Experimental)

27621 HIGH-SPEED SHOCK-WAVE INVESTIGATION IN RAREFIED GAS. Masoud, M.; El-Khalafawy, T. A.; Souprunenko, V. A. (Atomic Energy Establishment, Cairo). Nucl. Fusion, 9: 49-51(Mar. 1969).

High-speed shock-wave propagation in a cylindrical tube at low initial gas pressure has been investigated. A shock-wave was excited by fast magnetic compression of a plasma in a conical θ-pinch-type electrodeless device. The Mach number varied from 10 to 100, and the initial pressure from 20 to 250 μm Hg. At high initial pressures the shock-wave properties were identical to those of a "snow-plough" model. At low pressures an anomalous wave attenuation was observed that could not be explained by the existing theory. The shock-front width is in good agreement with that predicted by the ion-ion collision theory. (auth)

27622 EXCITATION OF INTENSIVE HIGH-FREQUENCY OSCILLATIONS IN BEAM–PLASMA DISCHARGE. Bez'yazychnyi, I. A.; Berezin, A. K.; Buts, V. A.; Kurilko, V. I.; Fainberg, Ya. B. At. Energ. (USSR), 26: 256-9(Mar. 1969). (In Russian).

Results of experimental investigations of interaction of originally unmodulated electron beams with plasma in the optimal conditions for excitation of intensive high-frequency oscillations are presented [beam energy 25 keV, beam current 28 A, pulse repetition rate 50 c/sec, pulse duration 4.5 μsec, beam diameter 2 cm, length of interaction region 40 cm, longitudinal magnetic field strength 1000 to 2000 Oe, gas working pressure (hydrogen, air, argon) 5×10^4 to 10^{-3} torr]. The spectra of excited oscillations in the range of 600 to 8000 Mc and the relation between the radius of the interaction region and the electron beam (~1,8) in the case when the generated oscillations power reaches its maximum value (120 to 150 kw) are determined. The results of the measurements show a good agreement with the theory. (auth)

27623 EXPERIMENTAL DETERMINATION OF THE CROSS SECTIONS FOR NEUTRAL BREMSSTRAHLUNG. II. HIGH TEMPERATURE AIR SPECIES: O, N, AND N_2. Taylor, R. L.; Caledonia, G. (Avco Everett Research Lab., Everett, Mass.). Contract F04701-68-C-0036. J. Quant. Spectrosc. Radiative Transfer, 9: 681-96(May 1969).

The low-energy cross sections for neutral bremsstrahlung for the major species of high temperature air—O, N, and N_2—were measured. The experiments were performed behind reflected shocks by measuring the absolute infrared intensity of appropriate shock-heated gas mixtures. The radiation was directed with a rapid-scanning infrared spectrometer covering a total-spectral range of 2.0 to 5.4 μ. The data were analyzed by assuming that the observed continuum was due to free–free scattering of electrons from the neutral species in the gas studied. The neutral bremsstrahlung cross section was determined for (1) atomic oxygen in O_2–Ne mixtures, (2) atomic nitrogen in N_2–Ne mixtures, and (3) for molecular nitrogen from data on pure N_2. Further checks on the experimental values were obtained by comparing the measured cross sections against intensity data from air and N_2–Ar and N_2–Ne mixtures. The data were analyzed for the "effective nuclear charge squared" and radiation absorption cross section of the active species. The data are compared with previous experimental measurements and with theoretical calculations. (auth) (UK)

27624 EXPERIMENTAL DETERMINATION OF THE CROSS SECTIONS FOR NEUTRAL BREMSSTRAHLUNG. I. Ne, Ar, AND Xe. Taylor, R. L.; Caledonia, G. (Avco Everett Research Lab., Everett, Mass.). Contract F04701-68-C-0036. J. Quant. Spectrosc. Radiative Transfer, 9: 657-79(May 1969).

Experimental measurements of the cross sections for radiative scattering of electrons from the neutral species Ne, Ar, and Xe were obtained. The experiments were performed in shock-heated gases from 8000 to 15,000°K using a rapid-scanning spectrometer to measure the absolute intensity of the neutral bremsstrahlung continuum over the wavelength interval of 2.0 to 5.4 μ in the infrared. The data were analyzed to obtain the "effective nuclear charge squared" Z_i^2, of the species i covering the scattering, using a modified form of the Kramers–Unsöld equation, and to obtain the radiative absorption cross section Qa_i. Experimental information on the temperature and wavelength dependence of the neutral bremsstrahlung was obtained. The experimental Qa's were compared with calculations based on a simple theory of radiative scattering of electrons from neutral species. (auth) (UK)

27625 EXPERIMENTAL STUDY OF RUNAWAY ELECTRONS IN AN AXIAL-FIELD PLASMA BETATRON. Yatsu, Kiyoshi (Tokyo Univ.). Jap. J. Appl. Phys., 8: 606-13(May 1969).

A formation of runaway electron beam in plasma by externally applied strong electric field and interactions of the runaway electron beam with the plasma were studied experimentally in a figure-eight-shaped toroidal device. Accelerated electrons were a relatively small fraction of the electrons in the plasma. An intense microwave radiation was observed and measured in detail. A limit of the beam current and the radiation were found to result from instabilities caused by coupling of a slow wave of the beam and plasma waves. (auth)

Kinetics (Theoretical)

27626 (AD–677339) RESEARCH REPORT ON TRANSPORT THEORY FOR MULTI-COMPONENT PLASMA. Scientific Interim Report. Kahan, T. (Oxford Univ. (England). Engineering Lab.). July 1968. 58p. (AFOSR–68-2010). CFSTI.

The behavior of a plasma with several components, i.e., a completely ionized (or binary) plasma and a partially ionized (ternary) plasma is studied. The problem is analyzed by means of the Boltzmann and Fokker–Planck equations. The methods used by Enskog–Chapman are generalized for the case of the multicomponent gas where the different equations are coupled with each other. In particular the question is studied of what becomes of the collision operators when the plasma is made up of several components. When there is a common equilibrium temperature the Enskog–Chapman approach goes through. When the components have different temperatures a system of eigenfunctions of the collision operators cannot be found, but expansions in terms of functions akin to the Sonine polynomials are possible. Another method is sketched which takes advantage of the different orders of magnitude of the various collisional integrals leading to a coefficient matrix which converts the system of coupled equations into a set of integral equations. The binary case is compared with Braginskii's results. Possible methods for the computation of transport coefficients when the components are not in thermal equilibrium are discussed. (auth) (USGRDR)

27627 (MATT-Q-26, pp 143-206) THEORY. (Princeton Univ., N. J. Plasma Physics Lab.).

Summaries of theoretical work during this period are given. (M.O.W.)

27628 (N-69-10471) COMPUTER EXPERIMENTS ON THE MICROSCOPIC BEHAVIOR OF ONE-DIMENSIONAL PLASMAS. Weinstein, Richard H.; Adams, Belinda H. (National Aeronautics and Space Administration, Langley Station, Va. Langley Research Center). Nov. 1968. 59p. (NASA-TN-D-4831). CFSTI.

The detailed motions of a system of 1000 particles simulating a one-dimensional electrostatic plasma were followed by using the IBM 7040/7094 Direct Coupled System at the Langley Research Center. The particles interactions are collective and as the calculation proceeds stepwise through time, the position–velocity histories of all the particles completely specify the successive states of the system. These data constitute an experiment, upon which measurements can be made. The velocity distribution function, the Fourier harmonics of the potential energy, the spatial correlations of the electric field, and the drag and velocity diffusion of test particles are measured for the Maxwellian and uniform velocity distributions. Comparison of the present work with both earlier experiments and the predictions of zero- and first-order plasma kinetic theory have yielded generally good agreement for all measurements in both equilibrium and nonequilibrium plasmas. The detailed behavior of the long-wavelength harmonics of the potential energy is, however, unresolved for regions where the assumptions of the zero-order theory are not satisfied. (auth) (STAR)

27629 (N-69-10866) SYNCHROTRON RADIATION FROM ELECTRONS IN HELICAL ORBITS. Sakurai, Kunitomo (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Aug. 1968. 11p. (NASA-TM-X-63381; X-615-68-334). CFSTI.

This paper considers correction factors of some of the commonly used results of synchrotron radiation theory both in vacuo and in ambient plasmas. These revisions are important when the spectral distribution of synchrotron radiation and the wave frequency range in which the influence of ambient plasmas becomes serious are considered. (auth) (STAR)

27630 (N-69-18769) GYRO-SYNCHROTRON EMISSION AND ABSORPTION IN A MAGNETOACTIVE PLASMA. Ramaty, Reuven (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Jan. 1969. 54p. (NASA-TM-X-63454; X-611-69-23). CFSTI.

The intensity, spectrum, and polarization of gyro-synchrotron radiation from an arbitrary distribution of electrons in a magnetoactive plasma are calculated. These calculations are based on detailed theories of gyro-synchrotron emission and absorption as well as on the equations of radiation transfer in the limit of large Faraday rotation. By performing extensive numerical calculations for both isotropic and anisotropic electron distributions, the influence of reabsorption and the Razin effect on the spectrum and polarization of the radiation were investigated. Using the same formalism and calculations, the possibility of negative absorption in an anisotropic gyro-synchrotron source was investigated. (auth)

27631 (SC-CR-68-3559) TRANSPORT PROPERTIES IN PARTIALLY AND FULLY IONIZED PLASMAS. Kelleher, Dermod; Everett, Willis L. (Sandia Labs., Albuquerque, N. Mex.). Apr. 1968. Contract 48-4039. 75p. Dep. CFSTI.

Transport equations are developed for the number densities, mean velocities, temperatures, stresses, and heat fluxes of the constituents of an ionized gas by taking velocity moments of the Boltzmann equation. These equations are closed out by utilizing the Grad 13-moment approximation for each distribution function. This approximation provides a representation for the distribution function of each constituent which has as its first term a Maxwellian about the constituent mean velocity, and remaining terms which describe the deviation of the distribution function from this local-constituent Maxwellian and which have as their coefficients the constituent traceless stress tensor and the constituent heat flux vector defined relative to the mean constituent velocity. These equations, coupled with Maxwell's equations to describe the electric and magnetic fields, constitute a closed set. This set of equations is anticipated to have validity for plasma systems of arbitrary degree of ionization, the constituents of which need not be close to thermodynamic equilibrium with each other. By limiting attention to systems with slowly varying flows, transport expressions, which reflect the influence of electric and magnetic fields, have been extracted and exhibited. (auth)

27632 RELATIVISTIC CORRECTIONS TO THE DISTRIBUTION FUNCTIONS OF PARTICLES IN A HIGH-TEMPERATURE PLASMA. Kosachev, V. V.; Trubnikov, B. A. (Kurchatov Inst. of Atomic Energy, Moscow). Nucl. Fusion, 9: 53-6(Mar. 1969).

Single- and double-particle functions for a high-temperature plasma in thermodynamic equilibrium are found by integrating the general Gibbs distribution. The plasma itself is described by Darwin's Lagrangian so that relativistic effects can be taken into account with an accuracy to terms of the order of v^2/c^2. The single-particle distribution functions are shown to be somewhat different from the Maxwellian ones in this approximation. (auth)

27633 ISOPERIMETRIC SOLUTIONS RELATED TO THE THERMODYNAMICS OF PLASMAS. Chen, Robert L. W.; Neighbors III, Thomas H. (Emory Univ., Atlanta). J. Math. Phys. (N. Y.), 10: 439-42(Mar. 1969).

More solutions of isoperimetric problems are obtained which lead to several extensions and refinements of previous results in the thermodynamics of plasmas: (1) Energy requirement for density fluctuations in a relativistic plasma is determined. At the typical relativistic temperature of $kT = mc^2$ it becomes $\sim nkT(|\overline{\Delta n}|/n)^2$ as compared with the previous nonrelativistic value of $\sim {}^3\!/_5\, nkT(|\overline{\Delta n}|/n)^2$. (2) An optimum expression for the free energy in a plasma is derived in terms of familiar thermodynamic variables. (3) For a collisional plasma, the energy requirement again assumes the same general form and is equal to ${}^1\!/_2\, nkT(|\overline{\Delta n}|/n)^3$. (auth)

27634 ELECTRIC DIPOLE RADIATION IN ISOTROPIC AND UNIAXIAL PLASMAS. Kenny, John Joseph. Pasadena, Calif., California Inst. of Tech., 1968. 94p.

Thesis.

An investigation was made of radiation from an electric point dipole situated in a cold, collisionless, homogeneous, electronic plasma medium. Two limiting cases of a gyroelectric medium are studied. The magnetostatic biasing field B_0 is first taken to be equal to zero, making the medium isotropic, and then it is taken to be infinite, causing a uniaxial anisotropy. The retarded electromagnetic fields and the instantaneous and averaged values of irreversibly radiated power p^{irr} are calculated. (Diss. Abstr.) (TSS)

27635 SINGLE-PARTICLE MOTION IN MULTIPLE-CUSP MAGNETIC FIELDS. Dunnett, R. M. (Imperial Coll. of Science and Tech., London). Nucl. Fusion, 9: 82-4(Mar. 1969).

The calculations described relate to the Polytron experiment in which a series of cusp magnetic fields is superimposed on a toroidal pinch configuration. Diagrams relating the charged-particle motions are given. (M.O.W.)

27636 HARMONIC CURRENT GENERATION AND MULTI-SIGNAL EFFECTS IN BEAM-PLASMA SYSTEMS. Brackett, Charles Arthur. Ann Arbor, Mich., Univ. of Michigan, 1968. 225p.

Thesis.

The interaction of a velocity-modulated electron beam with a cold collisionless electron plasma is studied by a perturbation analysis which is carried through terms of third order in the depth of modulation parameter. The analysis is based on the continuity, force and Poisson's equations and is developed in a general manner which can be applied to terms of arbitrary order and to an arbitrary number of sinusoidal input signals. (Diss. Abstr.) (TSS)

27637 GYRORESONANT PARTICLE ACCELERATION IN A NON-UNIFORM MAGNETOSTATIC FIELD. Canobbio, E. (EURATOM-CEA, Gif-sur-Yvette, France). Nucl. Fusion, 9: 27-47(Mar. 1969).

Particle motion in inhomogeneous magnetostatic and high-frequency fields at the gyroresonance is studied in the limit of a large number of particle revolutions in the resonance region. The influence of the magnetic mirror, Doppler and relativistic effects, wave attenuation, and radiation pressure on particle acceleration is discussed. The time dependence of the orbital magnetic flux, the velocity along the magnetic lines of force and the width of the resonance region are calculated. An upper limit is found for the energy of the particle, when the effect of the magnetic field of the wave partially compensates for the change in mass with energy. The nonlinear method used is exact in the limit of many revolutions. It generalizes the results established by C. S. Roberts and S. J. Buchsbaum in a special case, to the more complex situation proposed by T. Consoli for injecting, accelerating, and confining a hot plasma in a magnetic trap. A number of numerical examples are presented for various conditions. The energy transfer to the particles at the parametric resonances is also investigated. The space-charge field that develops along the magnetic lines of force in a plasma accelerating structure is taken into account in the equations from the very beginning by assuming (Consoli) that the electron guiding centers move with the velocity of the ions. (auth)

27638 VALIDITY OF COMPLETE LOCAL THERMODYNAMIC EQUILIBRIUM FOR He I. Deutsch, C. (Laboratoire de Recherches Physiques, Paris). Phys. Lett., 28A: 752-3 (Mar. 10, 1969).

Tunneling characteristics in junctions made of granular Al exhibit a low frequency tail in the phonon spectrum. This supports the explanation for the superconducting transition temperature enhancement based on MacMillan's theory. (auth)

27639 RADIAL SELF-FOCUSSING OF AN ELECTRON BEAM IN A PLASMA UNDER BEAM INSTABILITY CONDITIONS. Krasovitskii, V. B. (Physical-Technical Inst., Kiev). Zh. Eksp. Teor. Fiz., 56: 1252-61(Apr. 1969). (In Russian).

The possibility of exploiting collective processes for the purpose of radial self-focusing of charged-particle beams is discussed. It is shown that such a possibility exists in the case of a restricted beam interacting with a plasma under beam instability conditions. Radial compression of the beam in this case occurs as a result of high-frequency pressure exerted by the surface plasma waves generated by the beam. The focusing time is of the same order of magnitude as the time for development of beam instability (of the order of the inverse increment). (auth)

27640 PLASMA-TRANSPORT PROPERTY CORRELATION USING IONIZATION FRACTION. Roschke, E. J. (California Inst. of Tech., Pasadena). Contract NAS7-100. AIAA (Amer. Inst. Aeronaut. Astronaut.) J., 7: 552-4(Mar. 1969).

It is shown that the calculational technique is not generally successful. It is shown that for singly ionized argon in equilibrium the effect of pressure is not effectively suppressed, but is increased when using ionization fraction rather than temperature as the independent variable. (M.O.W.)

27641 A CONTRIBUTION TO THE CALCULATION OF THE BREMSSTRAHLUNG IN PLASMA FREQUENCY REGION. Slechta, J. (Inst. of Thermomechanics, Prague). Czech. J. Phys., 19: 697-8(1969).

A simplified formula was obtained from the quantum Born approximation. The advantages of this Born formula are pointed out. (M.O.W.)

27642 ON THE INFLUENCE OF THE HALL EFFECT ON HIGH-CURRENT ARCS. Mayr, Otto. Wiss. Ber. AEG-Telefunken, 41: 88-91(1968). (In German).

As an introduction the physical events are discussed and expressed mathematically, which are responsible for the Hall effect in the plasma. The occurrence of a Hall current brings about the conversion of the plasma conductance, which may be measured by macroscopic methods—a scalar quantity without the Hall effect—to a three-dimensional tensor. On the model of the long arc it is deduced that no appreciable Hall current can flow in radial direction because a strong electrostatic opposing field is created from electrons deflected from their original direction. For short arcs, whose length is of the order of the diameter and which burn between flat electrodes, it is shown that spiral magnetic lines of force may be formed round the arc axis in consequence of the Hall effect. Hence, it may be explained why high-current arcs tend to spiral, i.e., to drift spirally, near the electrodes as has been observed during experiments from time to time. The axial and azimuth components of the arc current and its magnetic field, which lead to the formation of spiral geometry, may be calculated as a function of radius. The results are stated of some calculations for definite boundary conditions. (auth)

Production

27643 (ORO-3819-1) COLLISIONLESS SHOCK STUDIES USING LASER-PRODUCED PLASMAS. Progress Report, June 4, 1968–March 31, 1969. Koopman, David W. (Maryland Univ., College Park. Inst. for Fluid Dynamics and Applied Mathematics). Contract AT(40-1)-3819. 26p. Dep. CFSTI.

The present investigation is directed toward generating the collisionless shock wave by the interaction of the streaming laser plasma with a lower-density stationary background plasma produced from diffusion or discharge plasma sources, with adequate diagnostic measurements and sufficient control of conditions to allow a definitive comparison of the laboratory results to the theoretical predictions. The sections summarize the experimental facilities that have been developed and describe some of the preliminary results that have been obtained. Because the construction of the sources for the background plasma is not yet completed, no data is available on the collisionless shock phenomena. (auth)

Stability

Refer also to abstracts 27606 and 27665.

27644 (COO-1695-15) PLASMA INSTABILITIES AND WAVES EXCITED BY AN ANISOTROPIC ENERGY DISTRIBUTION PRODUCED BY ELECTRON CYCLOTRON RESONANCE. Quarterly Progress Report No. 8, December 15, 1968–March 14, 1969. Shohet, J. L. (Wisconsin Univ., Madison. Dept. of Electrical Engineering). Mar. 15, 1969. Contract AT(11-1)-1695. 34p. Dep. CFSTI.

The ability of a short pulse of electron cyclotron resonance radiation to produce an anisotropic energy distribution of electrons in a plasma, and the instabilities and waves produced by this anisotropy are investigated. In particular, the nature of the rf heating mechanism and the behavior of the radiation emitted from the plasma are considered. The electron cyclotron resonance device was operated both in a short rapidly repeating mode, and a long (up to 1 msec) mode to obtain measurements of free–free bremsstrahlung, wall bremsstrahlung, plasma diamagnetism, energetic electron flux and electron density in the discharge. An instability in the operation of the device was observed. This was characterized by rapid ejection of particles and rf emission. The onset of the instability was investigated as a function of the mirror ratio, magnet current, rf power and gas pressure. Theoretical work determined the nature of this instability to be of the electromagnetic type. Relativistic x-ray bremsstrahlung theory was expanded. Numerical evaluation of the Heitler differential scattering cross section was performed. A computer simulation of an electron cyclotron resonance plasma was made. It includes the self-consistent electric field of the electrons, the dc magnetic field and an external rf heating field. (auth)

27645 (TID-25037) INVESTIGATION OF UNIVERSAL PLASMA INSTABILITIES. Quarterly Report No. 11, September 1–November 30, 1968. Lashinsky, H. (Maryland Univ., College Park. Dept. of Physics and Astronomy). Contract AT(40-1)-3405. 13p. Dep. CFSTI.

The region of collisionless behavior in a Q-machine plasma was mapped. Plasma density profiles were taken at the two extremes. The observed profiles were asymmetric and a shift in the position of maximum density was noted. Plasma diagnostic work using an active Fabry–Perot microwave resonator is briefly discussed. (M.O.W.)

27646 STABILIZATION OF A CONFINED PLASMA BY AN OSCILLATING ELECTROMAGNETIC FIELD. Samain, A. (EURATOM-CEA, Fontenay-aux-Roses, France). Nucl. Fusion, 9: 80-2(Mar. 1969).

A collisionless plasma slab, at a uniform temperature, confined in a uniform magnetic field, was theoretically studied. The stabilization by an alternating electromagnetic field of the drift modes in the plasma was studied excluding the parametric amplification and nonlinear Landau effects. (M.O.W.)

27647 GENERAL ALGORITHM FOR THE INVESTIGATION OF PLASMA INSTABILITIES. Floriani, D. (Univ. of Innsbruck). Nucl. Fusion, 9: 77-9(Mar. 1969).

Recurrence formulas for the infinite number of coefficient functions are derived from the MGD equations. The time behavior of the system is discussed. (M.O.W.)

27648 CONVECTIVE AND ABSOLUTE TWO-STREAM INSTABILITIES FOR HOT PLASMA. Infeld, E.; Skorupski, A. (Inst. of Nuclear Research, Warsaw). Nucl. Fusion, 9: 25-6 (Mar. 1969).

The two-stream instability for arbitrary but equal temperatures of the streams is investigated. The equilibrium distribution function for a given temperature, which is the sum of two Maxwellian distributions, is approximated by resonance functions $\sim((v-v_0)^2+u_0^2)^{-1}$. The division of the two-stream instability into convective and nonconvective is described. Nonconvective instability occurs when the two streams are in opposite directions and the velocity of the slower of the two is greater than a critical value. This critical value is given with considerable accuracy by the empirical formula $v_c = v_1^{-1/3} u_0^{4/3}$; where v_1 is the speed of the faster stream and u_0 the "thermal" velocity. Comparison is made with a step-function distribution calculation performed by Sturrock. (auth)

27649 HELICAL INSTABILITY OF THE POSITIVE COLUMN MAGNETOPLASMA. Quinn, Robert Michael. Troy, N. Y., Rensselaer Polytechnic Inst., 1968. 91p.

Thesis.

An improved understanding of the nature of the helical instability of the positive column has been obtained by the application of theoretical and experimental techniques which are new to this field. The techniques of the theory of complex functions have been applied to the examination of the properties of the dispersion relation of this system. An investigation of the loci of the poles of the response function in the complex wave-number plane as a function of complex frequency has established the convective nature of this instability. A mapping technique has been utilized to predict the critical values of the system parameters. Close agreement between theory and experiment is found utilizing both experimental results previously available and new experimental results obtained for a different range of the experimental parameters. The mapping technique also shows that the method used by previous workers to obtain predictions of the onset conditions for instability contains a mathematical inconsistency. This is shown to lead to significant error in the predicted values of the critical parameters under certain experimental conditions. The subthreshold excitation technique has been used to measure the real and imaginary parts of the wavenumber of the helical perturbations. The general features of the behavior of these parameters predicted by the mapping technique are confirmed by the experiment. (Diss. Abstr.)

27650 EFFECT OF DISSIPATION ON NONLINEAR INTERACTION. Jarmen, A. (Uppsala Univ.); Stenflo, L.; Wilhelmsson, H.; Engelmann, F. Phys. Lett., 28A: 748-9(Mar. 10, 1969).

It is found that phase changes due to dissipation can stabilize nonlinear instabilities, which otherwise grow faster then exponentially. Vice versa, it seems possible that dissipation effects destabilize situations which are otherwise stable. (auth)

27651 INFLUENCE OF NONLINEAR EFFECTS ON CURRENT INSTABILITY IN THE PLASMA. Kingsep, A. S. Zh. Eksp. Teor. Fiz., 56: 1309-20(Apr. 1969). (In Russian).

The effect of nonlinear scattering of waves on particles and of weak plasma inhomogeneity on current instability in the plasma is considered. The noise energy density in the stationary state and the heating law for the plasma components are estimated. It is shown that, under experimental conditions, nonlinear scattering of waves is a more-effective mechanism of damping than Coulomb collisions. Conditions under which a weak radial inhomogeneity of the plasma may be a more effective mechanism of establishment of the stationary state than nonlinear wave scattering are discussed. It is shown that longitudinal inhomogeneity cannot ensure a true stationary state for current instability. (auth)

Thermonuclear Processes

Refer also to abstracts 28003 and 28198.

27652 (MATT-Q-26, pp 207-62) ENGINEERING AND DEVELOPMENT. (Princeton Univ., N. J. Plasma Physics Lab.).

- DEWAR VESSELS—operation of, isochronic
  - —design and performance for persistent current applications
- INTERFEROMETERS—filters for Fabry–Perot, band-pass
- MAGNET COILS—field calculations for, computer program for generally oriented
- STELLARATORS—magnet ring dynamics in, levitated superconducting
  - —magnet ring stability in, facility for testing levitated
  - —design of spherator, mechanical
- STELLARATORS (C)—magnetic windings for, helical stabilizer
  - —signal correlator time-delay apparatus for
  - —magnetic surface structure improvement using linear circularizers
- THERMONUCLEAR REACTORS—control of deuterium–tritium, minimum regenerative heating time for, (T)
  - —tritium recovery from blankets of
- TRITIUM—recovery from fusion reactor blankets (M.O.W.)

27653 (UCRL-71535) COILS FOR THE SUPERCONDUCTING LEVITRON. Taylor, Clyde E.; Duffy, Thomas J. (California Univ., Livermore. Lawrence Radiation Lab.). Apr. 9, 1969. 18p. (CONF-690407-18). Dep. CFSTI.

From Symposium on Engineering Problems of Fusion Research, Los Alamos, N. Mex.

The superconducting Levitron system now under construction consists of an 80-cm-diam, 600-kA, superconducting levitated ring wound with Nb_3Sn tape conductor; six stationary superconducting coils wound with Nb–Ti wire; and an array of stabilizing control coils, also superconducting, wound with multi-core Nb–Ti material designed for low ac loss. The coil system is described in detail. Tests were made on several inductively energized Nb_3Sn coils to determine critical temperatures. These tests are described. (auth)

27654 PRODUCTION OF STRONG QUASI-STATIONARY MAGNETIC FIELDS IN UNCOOLED COILS WITH AC EXCITATION. Koetzold, Bernd Rudolf. Wiss. Ber. AEG-Telefunken, 41: 11-17(1968). (In German).

Magnetic field coils were designed to produce an induction of at least 100 kG in a useful space of at least 100 cm^3, whose field is as homogeneous as possible, for the investigation of the physical phenomena in arcs in a high-pressure plasma of high current density. The coils were to be rated in such manner that they can dispense with forced cooling during the necessary duration of excitation between 50 and 100 ms. The excitation power is supplied by a very-low-frequency ac generator. The peak value of the short-circuit alternating current at 8 to 10 Hz is scarcely influenced by the coil reactance under the conditions prevailing here. (auth)

Wave Phenomena

27655 (AD-681121) AN EXPERIMENTAL AND THEORETICAL STUDY OF WAVE MIXING IN A BOUNDED MAGNETOPLASMA. Report Nos. 43, Scientific-6. Kuhn, Lawrence (Columbia Univ., New York. Plasma Lab.). Aug. 1968. Contract AF19(628)-5832. 122p. (AFCRL-68-0437). CFSTI.

Generation of space-charge waves at uhf frequencies by the nonlinear interaction of two microwave signals in a magnetoplasma is described. The experiment was performed using a neon afterglow ($p = 0.02$ torr), which formed a post in a square x-band waveguide. The results of the experiment agree quantitatively with a calculation of the interaction which accounts for its finite geometry. The nonlinear coupling is found to result from a Lorentz force interaction between the electron velocity induced by one incident wave and the time-varying magnetic field of the other. A similar calculation and experiment were performed in which one microwave was scattered from a driven space-charge wave. Results of the two first-order interactions can be combined to give a realistic prediction of second-order processes such as ''optical mixing'' and parametric excitation. The nonlinear calculation used to describe these experiments is a special case of a general coupling principle developed here for calculating nonlinear wave interactions in finite anisotropic plasmas. As another example, the coupling principle is utilized to derive coupled-mode equations for a nonlinear magnetoplasma waveguide. (auth) (USGRDR)

27656 (CEA-R-3639) THEORETICAL AND EXPERIMENTAL STUDY OF A NON-LINEAR DISINTEGRATION PROCESS FOR A LANGMUIR WAVE. Perulli, Mariano (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1969. 200p. (In French). (EUR-4108). Dep.

Thesis. Submitted to Univ., Paris.

The Vlasov equation was used to calculate nonlinear coupling between three electronic plasma waves (Langmuir waves) which propagate in a cylindrical plasma column confined by a strong magnetic field. The disintegration of a Langmuir wave excited in the plasma column by means of an antenna was studied. Space structure measurements for various waves show that the resonance conditions (selection rules) are satisfied. The measured disintegration threshold is in agreement with the theoretical value within 30% and shows that this nonlinear mechanism appears when the oscillating density to the mean density ratio is about 10^{-3} to 10^{-2}. The variation of the spatial growth rate as a function of the amplitude of the disintegrated wave shows that the resulting waves are correlated in groups of three along the magnetic field even though the disintegrating spectrum appears in a wide frequency band. (auth)

27657 (N-69-10624) TRAPPED WAVES PROPAGATING ALONG A WARM PLASMA SLAB. Mitchell, J. D. (Pennsylvania State Univ., University Park. Dept. of Electrical Engineering). Sept. 15, 1968. 67p. (NASA-CR-97614; SR-324). CFSTI.

Trapped modes in a warm plasma slab partially filling a parallel-plate waveguide are studied. A two-fluid model with a scalar-pressure term for electrons is used to obtain the field solutions and dispersion equations for both a symmetric and antisymmetric longitudinal $\bar{E}$ field. The dependence of the dispersion relations on electron temperature, slab thickness, and waveguide width is studied. The quasi-static dispersion equation and a dispersion relation obtained by a heuristic argument are compared with the more rigorous dispersion relation, and the regions of validity are discussed. Good agreement is found between experimental data measured in a cylindrical system and the theoretical results of the slab geometry. Finally, the effects of Landau damping and electron–neutral collisional damping are considered. (auth) (STAR)

27658 (N-69-14525) EXPERIMENTAL OBSERVATION OF OSCILLATIONS DESCRIBED BY THE CONTINUITY EQUATIONS OF SLIGHTLY IONIZED DEUTERIUM, NEON, AND HELIUM GAS. Roth, J. Reece (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Dec. 1968. 58p. (NASA-TN-D-4950). CFSTI.

Low-frequency oscillations in the electron number density of a slightly ionized gas were observed in deuterium, neon, and helium over the frequency range from 10^2 to 8×10^4 Hz. These oscillations can be identified with periodic solutions to the neutral- and charged-particle continuity equations. The observed functional dependence of the wave form and of the peak-to-peak amplitude of the oscillation are qualitatively consistent with this mechanism. The frequency of the oscillation is independent of magnetic field strength and has the predicted square-root dependence on the product of electron and neutral number density. (auth) (STAR)

27659 (N-69-18189) DRIFT WAVES IN THE LINEAR REGIME. Rowberg, R. E.; Wong, A. Y. (California Univ., Los Angeles. Plasma Physics Group). Feb. 1969. 57p. (NASA-CR-99339; R-39). CFSTI.

A method of external excitation of density gradient drift waves in a stable, collision-dominated plasma is presented whereby the linear theory of drift waves is verified. The procedure permits limitation of the perturbation amplitude. The driven oscillations are coherent, nearly sinusoidal modes on which measurements of the plasma parameters are made. The linear dispersion relation derived from the fluid equations is verified demonstrating the strong stabilizing effect of transverse diffusion resulting from ion viscosity. An additional damping process resulting from ion loss at the cathodes is introduced whereby complete stabilization of the plasma to drift waves is possible. The dependence of the growth rate on the phase angle between the density and potential perturbation is shown in the regime where viscous damping is not dominant. Verification of the dependence of the axial wavelength on the sheath conditions at the plasma cathode boundary and on the length of the plasma column is demonstrated. (auth)

27660 NOISE IN COLLISION-FREE ALKALI METAL PLASMAS. Little, P. F.; Middleton, C. R. (Culham Lab., Abingdon, Eng.). Nucl. Fusion, 9: 67-75(Mar. 1969).

Oscillations in alkali metal plasmas generated by contact ionization have been attributed to unstable drift waves both in collision-free and collision-dominated plasmas. In the early experiments, however, the influence of the radial electric field E_r in causing rotation of the plasma column was ignored. In later work with collisional plasmas, measured E_r values were used to calculate frequencies in the rest frame of the plasma and so demonstrate unstable collisional drift waves. Measurements are reported on collision-free potassium and cesium plasmas. The radial electric field causes a Doppler shift comparable with the frequencies observed and often larger than the predicted frequency of the fastest-growing drift wave. When this is taken into account, the frequencies observed in potassium are within a factor of two of those predicted for the collisionless drift instability and the radial distribution of the density fluctuations show a peak away from the edge of the column. Other features are consistent with the interpretation of the noise in potassium as due to the drift instability. In cesium, edge effects predominate and the cause of the enhanced noise is not the drift instability. (auth)

27661 ELECTROSTATIC OSCILLATIONS IN INHOMOGENEOUS PLASMAS. Staton, Leo Douglas. Blacksburg, Va., Virginia Polytechnic Inst., 1968. 96p.
Thesis.

The problem of longitudinal electrostatic oscillations in inhomogeneous, one-dimensional plasmas is examined in several areas. First the question is considered regarding whether the Vlasov–Maxwell equations will allow a plasma system to evolve naturally toward a preassigned stationary inhomogeneous state such as one of the Bernstein–Greene–Kruskal mode. For the particular case in which the stationary state is characterized by an energy distribution function which is a constant for all energies up to a given maximum and zero for energies beyond, an extremization principle is developed which indicates that the total system energy is a minimum for the plasma. This stationary state then is inaccessible in general for a plasma prepared initially in a less restrictive manner. Further, such an inhomogeneous, stationary state is necessarily stable, a fact which is demonstrated directly by treating this case through an integral equation method. This integral equation is shown to degenerate into a Schroedinger-type differential equation, which is formally similar to the differential equation obtained in the hydrodynamic approximation for Maxwellian velocity distribution functions. Electrostatic oscillations in more general cases are treated through the Fourier–Hermite transformation of the coordinate and velocity variables. A new recursion technique utilizing an electronic computer is used to reduce the resulting algebraic equations to a homogeneous matrix equation whose column vector is proportional to the Fourier components of the electric field. The addition of a small collision term to the Vlasov equation facilitates the calculation of the Landau damping in the inhomogeneous plasma and allows the determination of the effects of collisions on the growth rate of the two-stream instability. The method is capable of treating arbitrary wavelengths, but works best for small degrees of inhomogeneity. Results of the work show that the usual practice in the long-wavelength regime of dropping the stationary electric field term from the Vlasov equation has the effect of overestimating the Landau damping when applied to the intermediate wavelength range. The effect of inhomogeneity upon the growth rates of the two-stream instability is shown to be a relative increase in the growth rates for the smaller wavenumbers and a more pronounced relative decrease for the higher wavenumbers. Collisions are shown to depress the growth rate of this instability, in contrast to some other work reported in the literature. (Diss. Abstr.)

27662 ECHOES AND SCATTERING FROM PLASMA IN A MAGNETIC FIELD. Blum, Fred Andrew Jr. Pasadena, Calif., California Inst. of Tech., 1968. 136p.
Thesis.

A study of the high-frequency properties of a low-temperature plasma column in a longitudinal magnetic field is described. The experimental observations give a relatively complete picture of the microwave (extraordinary mode) properties of the plasmas studied, encompassing continuous wave scattering and noise-emission measurements, as well as the demonstration of the occurrence of related echo processes. Theoretical developments deal largely with a physical model consisting of a one-dimensional slab of cold (zero temperature) plasma which is nonuniform in the steady state and immersed in a uniform magnetic field. (TSS) (Diss. Abstr.)

27663 AN EXPERIMENTAL STUDY OF ION CYCLOTRON WAVES IN A HOT PLASMA. Uman, Myron F. Princeton, N. J., Princeton Univ., 1968. 91p.
Thesis.

According to the theory of the propagation and absorption of ion cyclotron waves in a hot plasma, the wavelength approaches a minimum, non-zero value as the wave propagates into a magnetic beach where the wave frequency approaches the local ion cyclotron frequency. Furthermore, the damping of the waves is a sharply resonant function of the magnetic field strength, the square of the width of the resonance being proportional to the ion temperature for ion motion parallel to the magnetic field. These effects are observed in a plasma, confined in a linear magnetic mirror machine, for perpendicular ion temperatures in the range of 10 to 110 eV. The wave fields are measured with two magnetic probes, the plasma density is measured with 2- and 4-mm microwave interferometers, and the perpendicular ion temperature is measured with a diamagnetism probe. The theory is developed for the transport of amplitude of waves in a hot, finite plasma immersed in an inhomogeneous magnetic field. Quantitative agreement between theory and experiment is obtained. These measurements represent the first experimental observations of thermally broadened collisionless cyclotron absorption in a laboratory plasma. (Diss. Abstr.)

27664 KORTEWEG–DE VRIES EQUATION AND GENERALIZATIONS. III. DERIVATION OF THE KORTEWEG–DE VRIES EQUATION AND BURGERS EQUATION. Su, C. H.; Gardner, C. S. (Princeton Univ., N. J.). J. Math. Phys. (N. Y.), 10: 536-9(Mar. 1969).

The Korteweg–de Vries equation and the Burgers equation are derived for a wide class of nonlinear Galilean-invariant systems under the weak-nonlinearity and long-wavelength approximations. The former equation is shown to be a limiting form for nonlinear dispersive systems while the latter is a limiting form for nonlinear dissipative systems. (auth)

27665 EXPERIMENTAL AND THEORETICAL STUDIES OF THE ELECTROTHERMAL INSTABILITY IN A NONEQUILIBRIUM PLASMA. Gilpin, Robert Ridgeway. Pasadena, Calif., California Inst. of Tech., 1968. 116p.
Thesis.

Experimental and theoretical studies have been made of the electrothermal waves occurring in a nonequilibrium MHD plasma. These waves are caused by an instability that occurs when a plasma having a dependence of conductivity on current density is subjected to crossed electric and magnetic fields. Theoretically, these waves were studied by developing and solving the equations of a steady, one-dimensional nonuniformity in electron density. From these nonlinear equations, predictions of the maximum amplitude and of the half width of steady waves could be obtained. Experimentally, the waves were studied in a nonequilibrium discharge produced in a potassium-seeded argon plasma at 2000°K and 1 atm pressure. The behavior of such a discharge with four different configurations of electrodes was determined from photographs, photomultiplier measurements, and voltage probes. These four configurations were chosen to produce steady waves, to check the stability of steady waves, and to observe the manifestation of the waves in a MHD generator or accelerator configuration. Steady, one-dimensional waves were found to exist in a number of situations, and where they existed, their characteristics agreed with the predictions of the steady theory. Some extensions of this theory were necessary, however, to describe the transient phenomena occurring in the inlet region of a discharge transverse to the gas flow. It was also found that in a discharge away from the stabilizing effect of the electrodes, steady waves became unstable for large Hall parameters. Methods of prediction of the effective electrical conductivity and Hall parameter of a plasma with nonuniformities caused by the electrothermal waves were also studied. Using these methods and the values of amplitude predicted by the steady theory, it was found that the measured decrease in transverse conductivity of a MHD device, 50% at a Hall parameter of 5, could be accounted for in terms of the electrothermal instability. (Diss. Abstr.)

27666 EXCITATIONS OF ELECTROSTATIC ION-CYCLOTRON OSCILLATIONS IN WEAKLY IONIZED PLASMA PLACED IN AN EXTERNAL D. C. ELECTRIC FIELD. Milic, B.; Sunder, D. (Lebedev Inst. of Physics, Moscow). Nucl. Fusion, 9: 19-24(Mar. 1969).

The excitation of ion-cyclotron oscillations in a weakly ionized plasma placed in an external dc electric field parallel to the field of magnetization is considered and the threshold electron drift is determined. The process is treated kinetically, and elastic collisions of charged particles with neutrals are described by Boltzmann collision integral. It is shown that the oscillations begin in the long-wave region and that their excitation may depend on ion collisions. In moderate magnetic fields ($\nu_e \gg \Omega_i \gg \nu_i$) electron collisions significantly facilitate the process of excitation. (auth)

Shielding

Refer also to abstracts 28066, 28069, and 28080.

27667 (AD-680457) A VARIATIONAL SYNTHESIS METHOD FOR CALCULATING STRUCTURE SHIELDING DATA. Final Report. O'Reilly, Bruce D. (Atomics International, Canoga Park, Calif.). June 1968. Contract N00228-67-C-2317. 82p. (AI-68-51; USNRDL-TRC-68-51). CFSTI.

A study was made to find and apply improved numerical methods for solving the gamma-ray transport problem in multidimensional structures. It appears that such problems can be solved systematically, economically, and with acceptable accuracy by using the variational synthesis method. This method provides the means for obtaining approximate solutions for problems in multidimensional structures by joining together solutions of similar problems of lesser dimensionality and/or guesses for solutions based on intuition or past experience. (auth) (USGRDR)

27668 (AD-680949) FAST NEUTRON SPECTRUM AND DOSE RATE IN WATER AND IN ALUMINUM-WATER LAMINATIONS. Coulbourn, G. I.; Williamson, T. G. (Virginia Univ., Charlottesville. School of Engineering and Applied Science). Nov. 1968. 51p. (NDL-TR-116). CFSTI.

The fast neutron spectrum was measured by seven threshold reaction detectors at various distances from a point fission neutron source in water and in two aluminum and water mixtures. The attenuation of the fast neutron dose rate and of the thermal neutron flux was also determined. The experimental results were compared with calculations made with the ANISN computer code. By use of experimentally determined counting efficiencies, absolute saturation activities of the threshold reaction products were determined. A method of neutron spectrum unfolding was devised which represented the fast neutron spectrum by a group of successive exponentials calculated from the saturation activities. The reported spectra generally agreed with the results predicted by the ANISN code. The fast neutron dose rate was measured directly with p-i-n silicon diode dosimeters and indirectly by applying flux-to-dose conversion factors to the measured fast neutron flux. Good agreement was obtained between these measurements and calculations. The saturation activities from the ^{32}S (n,p) reaction were compared with the measured and calculated dose rates and an activity-to-dose-rate conversion factor was estimated. (auth) (USGRDR)

27669 (N-69-19113) TRANSMISSION OF 2.43-MeV ELECTRONS THROUGH THICK SILICON TARGETS. Singh, Jag J. (National Aeronautics and Space Administration, Langley Station, Va. Langley Research Center). Feb. 1969. 41p. (NASA-TN-D-5075). CFSTI.

The energy and angular distribution of electrons transmitted through silicon targets of various thicknesses have been measured for perpendicularly incident electrons of energy 2.43 MeV. The transmitted-electron spectra were measured with 5-mm-deep lithium-drifted silicon detectors. The experimental results have been compared with the Monte Carlo results obtained by Berger and Seltzer. The Monte Carlo program includes the effects of secondary electrons and photons and also the effects of ionization energy-loss fluctuations. The inclusion of these effects in the theoretical calculations has reduced the discrepancy between the theory and the experiment considerably. The target thickness at which the average cosine of the deflection angles reaches its asymptotic value is measured to be 2.5 ± 0.1 millimeters for 2.43 MeV-electrons normally incident on plane parallel silicon targets. (auth) (STAR)

27670 (ORNL-tr-3025) STUDIES ON SHIELDING AND SHIELDING CONCRETES. GENERAL REMARKS ON THE ATTENUATION OF RADIATION IN MATERIALS AND ON THE CONSTITUTION OF SHIELDING CONCRETES. EXPERIMENTS AND MEASUREMENTS ON ATTENUATION IN CONCRETES. Condat, M.; Lafore, P.; Lott, M.; Rastoin, J. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Bull. Inform. Sci. Tech. (Paris), No. 109, 21-38(1966). 27p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 21: 13302. (M.H.R.)

27671 (SLAC-Trans-93) ANGULAR DISTRIBUTION OF THICK-TARGET GAMMA BREMSSTRAHLUNG. Mamedov, R. A.; Kramer-Ageev, E. A.; Pozdnyakov, V. I. Translated for Stanford Linear Accelerator Center, Calif., from Izv. Akad. Nauk Azerb. SSR, Ser. Fiz.-Tekh. Mat. Nauk, No. 3, 131-4(1964). 9p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 19: 33510. (M.H.R.)

27672 (UJV-2126-R) S_N CALCULATION OF THE TRANSPORT OF PARTICLES IN THE CYLINDRICAL SHIELDING. Rataj, J. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Feb. 1969. 11p. (In Czech.). Dep.

The S_N solution of the one-dimensional Boltzmann equation in cylindrical multiregion geometry with anisotropic scattering is described. Attention is given first to adaptation of the scattering integral. The program, SNAN, was written for this method in the language, ALGOL, for the computer, GIER. A description of this program and a sample of the calculations are also included. (auth)

27673 (UJV-2129-R) MULTIGROUP CROSS SECTIONS CALCULATION FOR USE IN S_N. Rataj, J. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Feb. 1969. 16p. (In Czech). Dep.

The calculation of multigroup cross sections for use in S_N calculations of the Boltzmann equation is described. The methods of calculation of these constants for neutrons and photons are presented. The programs, MUN and MUG, were written for these methods in the language, ALGOL, for the computer, GIER. Descriptions of these programs are also included. (auth)

27674 (ZJE-30) THE PROGRAMME FOR OPTIMIZATION OF THE BIOLOGICAL SHIELDS OF THE REACTORS. Vlachovsky, K. (Skoda [Works], Pilsen (Czechoslovakia). Nuclear Power Plant Div.). Dec. 1968. 11p. Dep.

An algorithm for determining an optimum variant of a shielding is demonstrated. Use of this program confirmed the possibility of optimization in a relatively shorter time than by use of the program calculating the neutron fluxes and averaged quantities, when applying data of each variant separately. Results show that multilayer shielding is better than shielding containing two or three layers, however, the differences are not large. (TSS) (auth)

27675 PROTECTIVE BRICK AGAINST RADIOACTIVE RADIATIONS. Leuthold, Charles; Leuthold, Francoise. British Patent 1,150,789. Apr. 30, 1969. Priority date Oct. 11, 1966, Switzerland.

A brick made from a material opaque to radiation from radioactive sources is described. This brick comprises two parallel longitudinal side faces; two vertical end faces, one convex and one concave; and upper and lower horizontal faces, one convex and one concave. Each of the upper and lower faces is provided with a central recess of the same convexity and concavity respectively as their nonrecessed parts. The end, upper and lower faces of the brick are provided with flat shoulder edges. The alternation of the flat shoulder edges and the curved surfaces of the bricks allow the construction of a wall from the bricks opaque to radiation. (M.H.R.)

27676 TRANSVERSE SHIELDING CALCULATIONS FOR HIGH-ENERGY PHOTON BEAMS. O'Brien, K. (Atomic Energy Commission, New York). Nucl. Instrum. Methods, 70: 349-51(May 1, 1969).

The neutron dose equivalent rate transmitted through heavy concrete shielding at right angles to thick targets irradiated by 4- and 5-GeV photon beam has been calculated using neutron transport theory, and compared with experimental values. Good agreement was found in both cases. (auth)

27677 EXPERIMENTAL STUDIES ON GAMMA-RAY DOSE RATES FROM A ^{60}Co CYLINDRICAL SOURCE WITH SHELL-SHAPED SHIELDS. Kanemori, Yoshihiko (Mitsui Shipbuilding and Engineering Co., Ltd., Tokyo); Furuta, Yutaka. Nucl. Sci. Eng., 36: 238-45(May 1969).

Dose rates of gamma rays from a ^{60}Co cylindrical source surrounded coaxially by a cylindrical shield were measured in the radial direction in a plane passing through the midpoint of the axis of the source. The ^{60}Co was uniformly distributed in a water-like medium. The shield was composed of water and iron, each in a single layer, and of water and iron in a double layer. The concept of the dose buildup factor for a volume source was introduced and the behavior of gamma rays scattered from the shielded cylindrical source was considered. The variation of the dose buildup factor for the shielded cylindrical source as a function of the distance from the source is less than the variation for the unshielded source. The dose buildup factor for a cylindrical source, with and without shields, shows many features that differ from those generally observed, i.e., an infinite medium surrounding a point source and one obtained from the total gamma-ray dose rates calculated by integration of an attenuation kernel with dose buildup factors for a point isotropic source. The unique behavior of the dose buildup factor for the cylindrical source with a cylindrical shield is shown by supplemental experiments with a ^{60}Co point source to be due to the cylindrical shape of the source and shields. (auth)

Solid-State Physics

Radiation Effects

27678 (CEA-R-3712) IRRADIATION DAMAGE "DISPLACEMENT ZONE". Genthon, Jean-Pierre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jan. 1969. 137p. (In French). Dep.

It is well known that a charged particle moving in a solid slows down and can cause a cascade of displacements of the atoms in the solid. A study is made of the extent to which the cascade is made up of independent collisions as a function of the energy of the initial charged particle. When the distance between the collisions is small, they are no longer independent; the cascade, which then has to be considered as a whole, perturbs and locates, in the irradiated solid, a zone which has been named a "displacement zone." It is shown that the proportion of displacement zones increases with increasing atom size (high atomic number Z), with decreasing atomic distance D in the substance considered, and with decreasing energy of the ion undergoing the slowing-down process (although always remaining above a few hundred eV). The proportions obtained are higher than in the calculations of J. A. Brinkman. An interatomic potential required for this work has also been determined. (auth)

27679 (IPP-2/72) RECOVERY OF ION-BOMBARDED METAL SURFACES. Vernickel, H. (Institut fuer Plasmaphysik, G.m.b.H. Garching (West Germany)). Oct. 1968. 24p. (In German). (CONF-680950-1). Dep.

From 15th Field Emission Symposium, Bonn, Germany.

Activation energies for the recovery of ion-bombarded surfaces of W and Mo have been measured using field emission. After bombardment at 100°K, extended-range annealing is found. With W, it occurs between 100 and 900°K with activation energies between 0.2 and 2 eV, and with Mo between 100 and 750°K with activation energies of 0.2 and 1.5 eV. After low-bombardment annealing of W-surfaces takes place, mainly in two stages around 0.3 and 1.5 eV, a large dose blurs the structure of the annealing curves. It should be noted that annealing starts below room temperature. (auth)

27680 X-RAY STUDY OF THE LATTICE PARAMETER OF SILICON. Moyer, Norman Edward. Lafayette, Ind., Purdue Univ., 1968. 165p.

Thesis.

The lattice parameter of silicon has been measured as a function of initial impurity concentration, integrated irradiation flux, and annealing temperature. With an x-ray triple crystal spectrometer, determinations of the fractional difference in lattice parameter between two crystals were accurate to $\pm 3 \times 10^{-8}$, and determinations of fractional changes in lattice parameter of one crystal were accurate to $\pm 2 \times 10^{-8}$. Several undoped samples of low oxygen concentration were nearly perfect but had different lattice parameters because of differing concentrations of randomly distributed impurity atoms. The changes in lattice parameter caused by irradiation with 1-MeV electrons were observed. The general result was an expansion initially linear in integrated flux that gradually approached a saturation expansion which was directly proportional to the impurity content in samples doped with the same impurity. Changes in the lattice parameter of the electron-irradiated samples due to isochronal annealing were also studied. The arsenic-doped samples showed a reverse anneal in the 200 to 300°C range, a recovery stage in the 300 to 400°C range, and a final recovery stage in the 500 to 750°C range. A phosphorus-doped sample behaved very much the same as an arsenic-doped sample of the same resistivity. The behavior of a p-type sample was very similar to that of the n-type samples except that the reverse anneal was absent. The samples exhibiting mainly the effects of carbon showed only the high-temperature annealing stage. Finally, the change in the lattice parameter due to fast neutron irradiation and the isochronal anneal of this change were observed. The increase in lattice parameter was about two orders of magnitude larger than the saturation expansion of the 1-MeV electron irradiated samples. Also, doped and pure samples all showed about the same amount of damage. Finally, the annealing curves of all the samples were very similar. They had two main stages, one in the 100 to 200°C range and another in the 480 to 570°C range. The lattice parameter returned to its initial value after heating to 670°C for several minutes. All these observations mean heavy neutron damage is independent of impurity concentration and is fundamentally different from 1-MeV electron damage. (TSS) (Disser. Abstr.)

27681 COLOR CENTERS IN MAGNESIUM OXIDE. Kroes, Roger Lee. Columbia, Mo., Univ. of Missouri, 1968. 79p.

Thesis.

Single crystals of MgO were additively colored in magnesium metal vapor. These crystals were heated to temperatures of from 1600°C to slightly over 1800°C, and at magnesium vapor pressures up to approximately 4000 torr. The resultant change in the room-temperature optical-absorption spectrum showed an asymmetric absorption band which peaked at 4.96 eV, and had a width at half maximum of 0.8 eV. Analysis of this absorption band indicated that it was due to the creation of oxygen ion vacancies which trapped two electrons forming an F′ center. The activation energy for this process was found to be +1.53 eV. Magnesium oxide crystals additively colored in calcium metal vapor were found to produce essentially the same absorption spectrum as those heated in magnesium except that a much higher coloration was achieved for a given vapor pressure. The x irradiation of additively colored MgO crystals, both at room temperature and liquid nitrogen temperature, did not produce any significant change in their optical absorption spectra. (Diss. Abstr.)

27682 POST-ANNEALING CONDUCTANCE BEHAVIOR OF IMPLANTED LAYERS IN SILICON. Davies, D. Eirug (Ion Physics Corp., Burlington, Mass.). Appl. Phys. Lett., 14: 227-9(Apr. 1, 1969).

Isochronal annealing studies were conducted on implanted boron and phosphorus layers in silicon. It is shown that the sheet conductance rise on annealing is dependent on the temperature at which the silicon is maintained during implantation. From the standpoint of conductance, low-temperature implanting is to be favored. (auth)

27683 CHANGES OF OPTICAL REFLECTIVITY (1.8 TO 2.2 eV) INDUCED BY 40-keV ANTIMONY ION BOMBARDMENT OF SILICON. Hart, R. R.; Marsh, O. J. (Hughes Research Labs., Malibu, Calif.). Appl. Phys. Lett., 14: 225-6(Apr. 1, 1969).

The fractional change in the optical reflectivity of silicon in the 1.8- to 2.2-eV photon energy band was measured as a function of 40-keV antimony ion dose ($10^{11} - 10^{15}$ Sb/cm^2 at various implant temperatures (−160 to 405°C)). Approximate agreement is found between the change of reflectivity and previous measurements of lattice disorder as determined by backscattering of 1-MeV He ions. (auth)

27684 ION IMPLANTATION DAMAGE OF SILICON AS OBSERVED BY OPTICAL REFLECTION SPECTROSCOPY IN THE 1- TO 6-eV REGION. Kurtin, Stephen; Shifrin, Gordon A.; McGill, T. C. (Hughes Research Labs., Malibu, Calif.). Appl. Phys. Lett., 14: 223-5(Apr. 1, 1969).

Optical reflection spectra of crystalline, sputtered, and ion-implanted silicon specimens are presented. Characteristic aspects of the spectra of ion-implanted specimens are related to . lattice damage. (auth)

27685 ELECTRON SPIN RESONANCE STUDIES OF GAMMA-RAY AND ELECTRON IRRADIATED CALCIUM MOLYBDATE. Eng, William. Storrs, Conn., Univ. of Connecticut, 1968. 109p. Thesis.

Zeldes and Livingston have studied the effect of ^{60}Co gamma-ray irradiation on calcium tungstate by means of paramagnetic resonance. They have found two groups of paramagnetic lines corresponding to two different types of defects: hole-like and electron-like. They prefer for the former defect a model analogous to the V_k center in the alkali halides. In their model, an electron is missing from an oxygen ion, and the hole is shared by a neighboring oxygen. The model for the electron-like center suggested by these authors is a surplus electron attached to a tungstate ion forming a WO_4^{3-} complex near a lattice defect. In the present study, single crystals of calcium molybdate have been subjected to gamma rays and fast-electron irradiation at 77°K. The radiation effects have been studied by electron spin resonance and optical absorption techniques. No displacement-type defects have been found in calcium molybdate, even with 1-MeV electron irradiation. The experimental results parallel that of calcium tungstate in most cases, and tend to confirm the defect models preferred by Zeldes and Livingston. Two classes of crystal have been employed in the experiments: stoichiometric crystals and non-stoichiometric crystals having oxygen vacancies. The presence of oxygen vacancies causes the electron-like defects to be stable to a higher temperature, and also prevents these defects from being optically bleached. Evidence suggests that the electron-like defect is associated with an impurity ion and the hole-like defect is associated with lattice strain. In addition, a new defect has been observed which has an isotropic g value slightly greater than that of the free electron and which exhibits a four-line isotropic hyperfine structure. It is believed to be a delocalized hole associating with oxygen and stabilized near a sodium impurity substituting for a normal cation. This proposed model would be rather similar to the V_1 center postulated by Seitz for alkali halides. (TSS) (Diss. Abstr.)

27686 ESR STUDY OF γ-IRRADIATED K_2SeO_4. Aiki, Kunio; Hukuda, Kenzi (Kyushu Univ., Fukuoka). J. Phys. Soc. Jap., 26: 1066(Apr. 1969).

ESR measurements on K_2SeO_4 crystals irradiated at room temperature or liquid nitrogen temperature were performed at X-band and Q-band with 100 kHz magnetic field. The ESR spectrum of the SeO_4^- radical shows a peculiar change with temperature. On cooling, the lines split into two at -143.5°C. The results suggest that a crystal structure change occurs at this temperature, analogous to that in K_2SO_4 at -130°C. (D.L.C.)

27687 OBSERVATION OF ATOMIC COLLISIONS IN CRYSTALLINE SOLIDS. Nelson, R. S. Series Defects in Crystalline Solids, Volume 1. Amsterdam, North-Holland Publishing Co., 1968. 281p. 123s.

A critical account is given of the more important experimental work that has provided a basis for a better understanding of atomic-collision phenomena in crystalline solids. The significance of the regular nature of the crystal lattice in relation to atomic-collision processes is stressed, and collisions are divided into two regimes: primary collisions concerned with interaction of the incident particles with the solid, and secondary collisions concerned with events that occur as a result of lattice atoms recoiling from primary encounters. Some theoretical models are also introduced. Main headings are as follows: introduction; interaction of radiation with matter; experimental techniques; passage of charged particles through solids; the atomic collision cascade; observation of secondary collisions; related phenomena (thermal spikes, anisotropy of displacement energy, fission tracks). (UK)

27688 INTERPRETATION OF CHANNELED-ION ENERGY-LOSS SPECTRA. Robinson, Mark T. (Oak Ridge National Lab., Tenn.). Phys. Rev., 179: 327-42(Mar. 10, 1969).

The energy-loss spectra produced in beams of energetic He and I ions transmitted through planar channels in thin Au monocrystals have been explained by a simple model in which the ions execute transverse anharmonic oscillations in the channel between a pair of adjacent planes of target atoms and in which the stopping power of the medium is a function of the distance of the ion from the crystal planes. A quantitative comparison of this model with recent experiments is made using a plane-averaged potential based on Moliere's approximation to the Thomas–Fermi screening function to describe the oscillatory motion. The stopping power is found to obey the same functional dependence on the coordinates, but with a doubled screening length. The parameters of the model may be deduced directly from the experimental data. For He in Au, these parameters agree well with those expected from Firsov's treatment of the interaction potential between neutral atoms. For I in Au, the high charge of the ion leads to parameters which differ significantly from Firsov's theory. The data also suggest that the energy dependence of the stopping power for channeled ions may be somewhat different from that for randomly directed ones. (auth)

27689 POTENTIAL-ENERGY AND DIFFERENTIAL-STOPPING-POWER FUNCTIONS FROM ENERGY-LOSS SPECTRA OF FAST IONS CHANNELED IN GOLD SINGLE CRYSTALS. Datz, S.; Moak, C. D.; Noggle, T. S.; Appleton, B. R.; Lutz, H. O. (Oak Ridge National Lab., Tenn.). Phys. Rev., 179: 315-26(Mar. 10, 1969).

Structure has been observed in the energy-loss spectrum of ions channeled between low-index planes in thin Au single crystals. It is proposed that the cause of this structure lies in the nature of the transverse oscillations of the ion in the interplanar potential. The particle's motion is characterized by an anharmonic oscillation; the wavelength is a function of the amplitude, and each amplitude is characterized by an energy loss. With narrowly collimated beams and small-angle detector, only particles having an integral number of wavelengths within the crystal are detected. Measurement of the wavelengths gives information about the interplanar potential. The dependence of energy loss on amplitude gives a mapping of the stopping power in the channel. Various features of the model are tested and quantitative measurements for 3-MeV ^{4}He ions and 60-MeV ^{127}I are given. Correlations with atomic parameters are discussed. (auth)

Physical Properties

Refer also to abstract 28561.

27690 (IS-T-298) THERMAL CONDUCTIVITY OF THORIUM. Schettler, Heinrich Gustav (Ames Lab., Iowa). Feb. 1969. Contract W-7405-eng-82. 46p. Dep. CFSTI. Thesis.

The thermal conductivity and the electrical resistivity of high-purity thorium samples were measured as functions of temperature from 3 to 300°K. The steady-state heat flow method was used for the thermal conductivity measurements. Between 6 and 25°K, the ideal electrical resistivity showed a $T^{3.75}$ temperature dependence. Above 60°K the resistivity was found to depend linearly upon temperature. The thermal conductivity was an order of magnitude greater than the thermal conductivity previously reported on less-pure samples. Above 60°K the thermal conductivity was found to be constant for the purest samples, contrary to previous reports which gave a linear increase. From the lowest temperatures to the maxima of the thermal conductivity curves a linear temperature dependence indicated impurity and lattice-defect scattering to be dominant. Impurity scattering was appreciable to about 20°K. From 12 to 20°K, the thermal resistivity was proportional to $T^{1.41}$ and the ideal thermal resistivity proportional to $T^{2.1}$. (auth)

27691 (INP-600/PS) MOLECULAR DYNAMICS STUDIES BY NEUTRON INELASTIC SCATTERING AND COMPETING METHODS. Janik, J. A. (Institute of Nuclear Physics, Krakow (Poland)). Apr. 1968. 57p. Dep.

The subject "molecular dynamics" is discussed in this paper stressing two points: (1) understanding of the process of neutron scattering by molecules of a gas or by what is called molecular groups in solids and liquids; and (2) obtaining information concerning molecular motions from neutron inelastic scattering experiments and comparing them with those obtained from other methods. Substances with hydrogen bonds such as: ice, water, hydrates are discussed as examples, and also typically molecular substances, for instance, methane in various phases. (auth)

27692 (IS-T-277) HIGH MAGNETIC FIELD PROPERTIES OF GADOLINIUM, TERBIUM, AND HOLMIUM. Cornforth, Clarence Michael (Ames Lab., Iowa). Feb. 1969. Contract W-7405-eng-82. 61p. Dep. CFSTI. Thesis.

A vibrating-sample magnetometer was used to measure magnetizations of Gd, Tb, and Ho in fields up to 100 kOe. Gadolinium was found to have a spontaneous saturation magnetization at 4.2°K of 7.49 μ_B per atom and a high-field susceptibility of 3.3×10^{-5} emu/g-Oe. The density of states at the Fermi energy was calculated to be 3.3×10^{34}/erg-cm^3 and the interaction energy between ions and conduction electrons found to be 1.26×10^{-13} erg. Terbium had a spontaneous saturation magnetization at 4.2°K of 9.28 μ_B per atom and a high field susceptibility of 7.3×10^{-5} emu/g-Oe. Calculations of the density of states at the Fermi energy and the interaction energy between ions and conduction electrons gave 5.74×10^{34}/erg-cm^3 and 4.3×10^{-14} erg, respectively. A transition from antiferromagnetic structure to antiphase structure was found for holmium at 12°K. (auth)

27693 (IS-T-295) TRANSVERSE MAGNETORESISTANCE IN VANADIUM AND IN A CHROMIUM-RICH CHROMIUM–VANADIUM ALLOY. Nelson, Kerry Scott (Ames Lab., Iowa). Feb. 1969. Contract W-7405-eng-82. 54p. Dep. CFSTI. Thesis.

Transverse magnetoresistance measurements were made on an oriented single crystal of high-purity vanadium in magnetic fields up to 48 kOe at liquid helium temperatures. The results are believed to represent the first experimental evidence of Fermi surface anisotropy in vanadium metal. The major features of the anisotropic magnetoresistance behavior reveal that the Fermi surface of vanadium is qualitatively similar to that of niobium and tantalum. For a ⟨110⟩ oriented vanadium crystal, the measurements are consistent with open orbits occurring when the magnetic field is near a ⟨001⟩-type symmetry direction. The transverse magnetoresistance of an oriented chromium–vanadium alloy single crystal, containing 1.04 at. % vanadium, was studied at liquid helium temperatures in magnetic field intensities up to 48 kOe. Although the residual-resistance-ratio is very low (RRR = 13), information about Fermi surface topology is discernible in the angular dependence of the data. Even with sufficient vanadium to appreciably reduce the strength of the antiferromagnetic ordering, the anisotropy of the data is similar to that of pure chromium. (auth)

27694 (NP-17819, Chap.3.1) SOLID-STATE PHYSICS. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)). 17p.

ELECTRON MICROSCOPY—use in studies of defects in solids
ION BEAMS—developments in low-energy bombardment experiments
IRON—phonon dispersion relations
MAGNESIUM OXIDES—magnetic susceptibility measurements
MANGANESE OXIDES—electric properties of lithium-doped single crystals of
MOLYBDENUM—radioinduced defects in, annealing spectrum of
NEUTRONS, FAST—effects on molybdenum, annealing of defects in
NICKEL—phonon dispersion relations
OXYGEN—diffusion in uranium dioxide
POLARONS—studies of
URANIUM OXIDES UO_2—oxygen diffusion in
—electric conduction mechanism
—Hall mobility of holes in single crystal of
—thermal conductivity at 4 to 300°K (D.L.C.)

27695 (RCN-104) AN ALGOL PROGRAM FOR THE REFINEMENT OF NUCLEAR AND MAGNETIC STRUCTURES BY THE PROFILE METHOD. Rietveld, H. M. (Reactor Centrum Nederland, Petten). Feb. 1969. 86p. Dep.

A structure refinement method is described which does not use integrated neutron powder intensities, single or overlapping, but employs directly the profile intensities obtained from stepscanning measurements of the powder diagram. Nuclear as well as magnetic structures can be refined, the latter only when their magnetic unit cell is equal to or a multiple of the nuclear cell. The least-squares refinement procedure allows, with a simple code, the introduction of linear or quadratic constraints between the parameters. The complete text of the Algol 60 program is given with a description of the format of the input tape. A test sample is included. (auth)

27696 MAGNETIC SUSCEPTIBILITY OF URANIUM(IV) GLASSES. Ostertag, Werner (Corning Glass Works, N. Y.). J. Amer. Ceram. Soc., 52: 61-2(Jan. 21, 1969).

The magnetic behavior of tetravalent uranium in glass was reinvestigated and new data are presented. Magnetic susceptibility measurements were made by the Gouy method on a series of uranium sodium silicate glasses containing 1.23, 2.77, 12.50, 22.20, 36.30, and 41.60 wt. % UO_2, and two thorium sodium silicate glasses, containing 1.23 and 41.6 wt. % ThO_2 and African sand. (M.H.R.)

27697 TEMPERATURE-DEPENDENCE IN THE SUSCEPTIBILITY OF Al_3V. Creveling, L. Jr.; Luo, H. L. (Univ. of California, San Diego, La Jolla). Phys. Lett., 28A: 772-3(Mar. 10, 1969).

The susceptibility of Al_3V was measured between 0.4 and 293°K and found to satisfy a Curie–Weiss expression with a critical temperature of ≈−65°K and an effective moment per vanadium ion of ≈0.32. No magnetic ordering appears to take place. These results are compared with those on Au–V alloys and Au_4V. (auth)

27698 MAGNETIC SUSCEPTIBILITIES OF SOME SULFIDES AND OXIDES OF PLUTONIUM. Raphael, Georges; de Novion, Charles (Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France). J. Phys. (Paris), 30: 261-6(Feb.-Mar. 1969). (In French).

Measurements were made of the paramagnetic susceptibilities of PuS, Pu_3S_4, $PuO_{1.52}$, Pu_2S_3 α and PuS_2 between 4°K and 1000°K. All these compounds show an antiferromagnetic point below 15°K. The paramagnetic susceptibility of PuS agrees with the calculated paramagnetic susceptibility of the Pu^{3+} ion in an octahedral field of 1000°K resulting from negative charges. (auth)

27699 ELECTRONIC AND LATTICE STRUCTURE OF CESIUM FILMS ADSORBED ON TUNGSTEN. MacRae, A. U.; Mueller, K.; Lander, J. J.; Morrison, J.; Phillips, J. C. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev. Lett., 22: 1048-51(May 19, 1969).

Data on elastic diffraction and inelastic scattering of electrons by Cs adsorbed on W in monolayer lattices suggest that, at monolayer densities equal to about half the bulk density, the decay rate of surface plasmons is much greater than for similarly situated monolayers of approximately bulk density. The enhanced decay rate is interpreted as evidence for nonmetallic character of the low-density layer, as proposed by Wigner for a low-density gas and by Mott for low-density aggregates of odd-valence atoms. (auth)

27700 STRAIN AGING OF NIOBIUM IN THE TEMPERATURE RANGE 100 TO 200°C. Soo, P. (Brookhaven National Lab., Upton, N. Y.). Phys. Status Solidi, 32: 815-21(Apr. 1, 1969).

Strain-aging experiments were conducted on polycrystalline niobium, containing approximately 100 ppM by weight of interstitial impurities. For aging temperatures in the so-called stage-III recovery region, which lies between 100 to 200°C, recovery occurs in two separate and independent substages. The first substage is thought to be caused by the detrapping of self-interstitials which are then able to migrate through the lattice and form new defect configurations. The second substage is probably connected with the migration of oxygen interstitials. The study indicates that the pinning of dislocations may also occur during the recovery and, under suitable conditions, dislocations may be successively pinned by self-interstitials, oxygen interstitials, and carbon (or nitrogen) interstitials. (auth)

27701 ELECTRICAL PROPERTIES OF URANIUM CARBONITRIDE. Ohmichi, Toshihiko; Kikuchi, Takeo (Japan Atomic Energy Research Inst., Ibaraki). J. Nucl. Sci. Technol. (Tokyo), 6: 101-2(Feb. 1969).

Measurements are reported of the electric conductivity and Seebeck coefficient of single-phase $UC_{1-x}N_x$ at 80 to 1000°K. The resistivity decreases with carbon content up to $x = 0.2$. The Seebeck coefficient is positive for both UN and $UC_{1-x}N_x$ and increases with temperature, reaching a maximum at ~600°K for UN. Its room-temperature value is ~50–60 μV/°K for UN and $UC_{1-x}N_x(0.3 < x < 1)$, and 25 μV/°K for UC. The conduction process and the antiferromagnetic spin-disorder of UN are discussed. (D.L.C.)

27702 THEORY OF MAGNETIC ORDERING IN THE HEAVY RARE EARTHS. Evenson, W. E.; Liu, S. H. (Ames Lab., Iowa). Phys. Rev., 178: 783-94(Feb. 10, 1969).

A detailed account is given of the calculation of the generalized susceptibility functions of Gd, Dy, Er, and Lu using realistic energy bands. These susceptibilities clearly show the influence of the Fermi-surface geometry in determining the helical ordering arrangements of the heavy rare earths, and the ferromagnetic ordering of Gd. A microscopic discussion of the magneto-elastic effect for a general ordered spin state is also presented. The first-order transition from the helical state to the ferromagnetic or conical ferromagnetic state in Tb, Dy, Ho, and Er is explained by this effect. Dy is used as an example of the application of the formalism, and a fundamental understanding is obtained of the transition between the helical and the ferromagnetic state and of the anomalous thermal expansion in both ordered states. (auth)

27703 PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON LUMINESCENCE, BUDAPEST, 1966. 2. Szigeti, G. (ed.). Budapest, Akademiai Kiado, 1968. 853p. (CONF-660818-(Vol.2)).

This volume includes luminescence of oxyphosphors, miscellaneous inorganic luminophors, rare-earth-activated luminophors, electroluminescence and injection phenomena, applications of luminescence, and resonance methods in luminescence research. (L.M.T.)

27704 PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON LUMINESCENCE, BUDAPEST, 1966. 1. Szigeti, G. (ed.). Budapest, Akademiai Kiado, 1968. 1311p. (CONF-660818-(Vol.1)).

Two volumes present (in English) the 304 papers presented at the conference. Practically all aspects of luminescence are dealt with, and the most up-to-date results achieved in various countries of the world up to the time of the conference are presented. This volume includes the introductory lectures (3), general problems of luminescence, general problems of luminescence of organic materials, long-duration luminescence processes, intra- and intermolecular energy transfer phenomena, special problems in organic luminescence, luminescence of halogenides, and luminescence of sulfides. (L.M.T.)

27705 MULTIBAND THEORY OF INELASTIC NEUTRON SCATTERING BY FERROMAGNETIC METALS AT LOW TEMPERATURES. Sokoloff, J. B. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 180: 613-21(Apr. 10, 1969).

The behavior of the inelastic neutron scattering cross section of ferromagnetic metals at temperature $T = 0$ was examined as a function of scattering vector K. When spin–orbit coupling is negligible, because of invariance of the metals under rotation of the total spin of the system, there will be no inelastic neutron scattering at $K = 0$. In those ferromagnetic metals for which hybridization with the conduction band is unimportant, this effect is shown to occur for K = a reciprocal-lattice vector τ_n. It is argued that, for $K \neq \tau_n$, there should still be no interband spin wave, optical spin wave, or Stoner-mode inelastic scattering, but only acoustic spin-wave scattering for ferromagnetic metals with magnetic bands sufficiently narrow to be nearly described by a Heisenberg model. It is shown by explicit calculation on a simplified multiband model that for wider-band ferromagnetic metals, if there exist optical and interband spin waves in addition to an acoustic spin-wave mode, it should still be difficult to observe Stoner modes. The effect of conduction-band–d-band hybridization on the inelastic neutron scattering from 3d-series metals is examined: Its effect in nickel is shown to be small, but its effect is argued to be larger for iron. It is concluded that it should be easier to observe interband and optical spin waves and Stoner modes in iron than in nickel because this metal is further from being described by a Heisenberg model than nickel. (auth)

27706 DIELECTRIC PROPERTIES OF FILM OXIDES OF SOME RARE EARTH ELEMENTS. Kadzhoyan, R. H.; Egiyan, K. A. Izv. Akad. Nauk Arm. SSR, Ser. Fiz., 3: 348-54(1968). (In Russian).

Methods of obtaining film oxides of some rare earth elements are discussed. Features of deposition of these oxides are given. Two different methods of obtaining neodymium oxide films are described. The effect of temperature and frequency and strength of the applied electric field on dielectric properties of neodymium oxide films is studied. (auth)

27707 NORMAL VIBRATION MODES OF BERYLLIUM OXIDE. Nusimovici, Michel A. (Faculte des Sciences, Paris. CNRS, Paris). Compt. Rend., Ser. B, 268: 755-8(Mar. 10, 1969). (In French).

A model was developed for the determination of the correct vibration frequencies of a crystal showing wurtzite structure. This model was used to study the lattice dynamics of the beryllium oxide. A certain number of calculated dispersion curves can be directly compared with the dispersion curves obtained by neutron scattering. The agreement between theoretical and experimental results is very satisfactory. (tr-auth)

27708 PHONON EMISSION AND SELF-ENERGY EFFECTS IN NORMAL-METAL TUNNELING. Rowell, J. M.; McMillan, W. L.; Feldmann, W. L. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 180: 658-68(Apr. 15, 1969).

The dependence of conductance on voltage for metal/insulator/metal junctions for the bias range from 0 to 1 V is discussed. The dependence is roughly parabolic but the minimum conductance need not occur at $V = 0$. Small deviations from this parabolic conductance behavior are described. These are due to interactions of the tunneling electrons with impurities in the oxide, the oxide itself, or the surface layers of the metal electrodes. These emission processes are studied by calculating the even conductance and its derivative. This derivative, at low voltages, is a crude measure of the phonon density in the normal-metal electrode. It is shown that self-energy effects in the normal metal can be conveniently displayed by calculating the odd conductance. Such experimental effects are presented for normal Pb, and are in good agreement with the self-energy calculated from superconducting tunneling. (auth)

27709 RESISTIVITY ANOMALIES IN GADOLINIUM. Nellis, W. J.; Legvold, S. (Ames Lab., Iowa). J. Appl. Phys., 40: 2267-9(Apr. 1969).

Anomalous behavior has been observed in the electrical resistivity of gadolinium single crystals in the region 210 to 250°K. The results are correlated with the rapid deviation of the magnetic moment from the hexagonal axis in this temperature range. (auth)

27710 THERMAL CONDUCTIVITY OF KCl:Li. ISOTOPE AND ELECTRIC FIELD EFFECTS. Peressini, P. P.; Harrison, J. P.; Pohl, R. O. (Cornell Univ., Ithaca, N. Y.). Contract AT(30-1)-2391. Phys. Rev., 180: 926-30(Apr. 15, 1969). (NYO-2391-88).

The resonance scattering of phonons in KCl : Li has been studied through thermal-conductivity measurements of crystals containing ^{6}Li and ^{7}Li, and also of crystals in which the tunneling states of the lithium ion were polarized through an applied electric field. In all cases the resonance scattering can be very well described phenomenologically with a single-resonance relaxation rate of the form $(nA/\omega_0^3)(\omega/\omega_0^2/[1-(\omega/\omega_0)^2]^2$, where ω_0 appears to be the weighted average of the tunneling frequencies. The lighter isotope causes an upward shift of ω_0 by 45%, which agrees with the isotope effect observed for the tunnel splitting in specific-heat measurements. This is considered strong evidence that the phonon scattering is indeed caused by an interaction with the tunneling states. The electric-field-induced shift of ω_0 also is consistent with the known Stark shifts of the tunneling states. The single resonance is explained with the picture that all tunneling states contribute to the scattering, and that the resolution of the thermal-conductivity measurements used for phonon spectroscopy is insufficient to resolve the scattering by the individual states. The scattering strength A, to a good approximation, is found to be proportional to ω_0^2, regardless of whether ω_0 is changed by applying electric fields or by changing the isotopic mass. This behavior is that of a classical oscillator which is damped by radiation at its resonance frequency ω_0. It is concluded that the combined scattering by the tunneling states, as observed in thermal conductivity, is similar to that of a classical oscillator. For lithium concentrations in excess of 3×10^{18} cm^{-3}, the thermal conductivity saturates below 1°K. This behavior is similar to that observed earlier in specific-heat measurements. (auth)

27711 ISOTOPE EFFECT IN DIFFUSION. Glyde, H. R. (National Research Council of Canada, Ottawa). Phys. Rev., 180: 722-5(Apr. 15, 1969).

A derivation of the classical jump rate Γ for tracer diffusion aimed at a clear expression for the mass dependence of the frequency factor $\bar{\nu}$ is presented. The derivation is effected without using the usual collective normal coordinates which usually combine the masses in a complicated way. $\bar{\nu}$ depends explicitly on the mass of the surrounding host atoms (as well as on the tracer-atom mass) if these atoms must move to new equilibrium positions after the jump. $\bar{\nu}$ then has much the same form as suggested for a many-atom jump process. The contribution of the surrounding atoms is reduced (increased) for light (heavy) tracer atoms. (auth)

27712 DECREASE OF MAGNETIZATION OF ITINERANT ELECTRONS BY SPIN–ORBIT SCATTERING ON IMPURITIES. Wohlleben, D.; Luo, H. L. (Univ. of California, San Diego, La Jolla). Phys. Rev. Lett., 22: 842-5(Apr. 21, 1969).

The exchange-enhanced magnetic susceptibility of Sc and Ni_3Ga decreases strongly when small amounts of nonmagnetic impurities are added. The decrease is a linear function of the spectroscopic spin–orbit energy of the impurity at constant valency and has the same origin as the decrease of the Curie temperature of Ni in dilute Ni : Pd and Ni : Pt. (auth)

Moessbauer Effects and NMR

Refer also to abstract 26523.

27713 (UCRL-18675) TEMPERATURE DEPENDENCE OF THE HYPERFINE INTERACTION IN DILUTE NICKEL ALLOYS USING GAMMA–GAMMA PERTURBED ANGULAR CORRELATION. Rosenblum, Stephen Saul (California Univ., Berkeley. Lawrence Radiation Lab.). Jan. 1969. 111p. Dep. CFSTI. Thesis.

Perturbed angular correlation studies of temperature-dependent hyperfine fields at ^{111}Cd, ^{99}Ru, and ^{100}Rh solutes in nickel above and below the Curie point are presented. For ^{111}CdNi, it is found that the hyperfine field is proportional to the lattice magnetization over the entire range of temperatures studied. For ^{99}RuNi, this is not the case, and a molecular field model is described which accounts for this behavior by postulating a local moment on the ruthenium atom. For ^{100}RhNi, all data was taken for $T_c \lesssim T \leq 1.2\ T_c$ and the hyperfine field was found to be proportional to the lattice magnetization. In addition, a time-dependent interaction is seen in this case, which is accounted for by a model based on the exchange-narrowing of a broadened Zeeman transition. Angular-correlation apparatus capable of 0.1% accuracy and a furnace capable of ±.5°C stability over 24 hours for use with this apparatus are also described. (auth)

27714 RECOILLESS RESONANCE ABSORPTION BY THE 6.2-keV STATE IN ^{181}Ta. Sauer, Christian (Technische Hochschule, Munich). Z. Phys., 222: 439-54(1969). (In German).

A strong recoilless resonance absorption was observed for the extraordinarily narrow 6.2-keV level ($T_{1/2}$ = 6.8 μsec) of ^{181}Ta. Using sources of ^{181}W in W-metal and Ta-metal absorbers, a linewidth of about 9 times the natural width was obtained, with an enormous isomer shift of +(0.85 ± 0.02) mm/sec, which is equivalent to a shift by 260 times the natural linewidth. Recoilless resonance spectra of cold-worked and of oxygen-doped absorbers showed a high sensitivity of the linewidth to lattice imperfections due to inhomogeneous quadrupole interactions and isomer shifts. Measurements of the residual resistivity ratio and of the lattice constant of the impurity-doped absorbers yielded a linear correlation between linewidth and isomer shift. (auth)

27715 NUCLEAR MAGNETIC RELAXATION OF ^{31}P IN DIAMAGNETIC ThP AND THE PARAMAGNETIC STATE OF UP. Kuznietz, Moshe; Matzkanin, G. A. (Argonne National Lab., Ill.). Phys. Rev., 178: 580-5(Feb. 10, 1969).

The spin-lattice relaxation time T_1 and free-induction decay time constant T_2^* for ^{31}P as functions of temperature and applied magnetic field were studied in diamagnetic thorium monophosphide (ThP) and the paramagnetic state of uranium monophosphide (UP) (antiferromagnetic below $T_N \simeq 125$°K). Both compounds have the same NaCl-type structure and similar low electrical resistivities, so that the effect of the magnetic character of UP is manifested in the different behavior of the relaxation times in UP as compared with ThP. T_2^* has been determined from the shape of the Bloch decay following a 90° pulse; T_1, from the amplitude of the Bloch decay following a 180°−90° pulse sequence. Pulse measurements were carried out at 4, 8, and 12 MHz and 77−303°K; the values obtained are consistent with the previously reported continuous-wave (cw) data. In ThP, T_2^* is 140 ± 5 μsec and is independent of temperature and magnetic field, while $T_1T = 16.2 \pm 0.8$ sec °K is constant. This supports the metallic behavior and the Korringa mechanism for the relaxation. The ratio of the experimental $T_1TK_c^2$ to the theoretical Korringa value is 1.95 ± 0.25, which is comparable to that of other metals. In UP, T_2^* values are 15−70 μsec, with the same temperature and field dependence as the cw linewidth. The T_1 values are three orders of magnitude shorter than in ThP, but increase with temperature, and T_1T increases strongly with temperature. However, when the T_1T values are combined with the Knight shift K in UP, a Korringa-type relation $T_1TK^2 = (38 \pm 6) \times 10^{-6}$ sec °K is obtained, with a value of 24 ± 4 for the ratio of the experimental T_1TK^2 to the theoretical Korringa value. This ratio is higher than in most metallic materials. The Korringa-type relationship between T_1 and K in UP suggests that the relaxation is founded in the same mechanism as the Knight shift, namely, an indirect coupling between the ^{31}P nuclei and the uranium localized moments via the conduction electrons. The results in UP are compared with those in $\beta-UH_3$, which shows a different behavior in the paramagnetic state, and with other recent results. (auth)

27716 THE COMPUTATION OF MOESSBAUER SPECTRA. II. Gabriel, J. R.; Olson, D. (Argonne National Lab., Ill.). Nucl. Instrum. Methods, 70: 209-12(Apr. 15, 1969).

The extension of the computer programs UNIXTL, LVSPHS, and PDRHXT to deal with transitions of mixed multipolarity, and the use of density matrices to calculate Moessbauer spectra in the case where neither source nor absorber is a single unpolarized line are discussed. Methods for testing the programs and finding errors are outlined. (auth)

27717 NMR OF ^{14}N IN THE PARAMAGNETIC STATE OF URANIUM MONONITRIDE. Kuznietz, Moshe (Argonne National Lab., Ill.). Phys. Rev., 180: 476-81(Apr. 10, 1969).

Uranium mononitride (UN) has the NaCl-type structure, is a good conductor of electricity, is antiferromagnetic (type I) below ~53°K, and obeys the Curie−Weiss law in the paramagnetic state in the temperature range 77−300°K. A continuous-wave NMR study was carried out on ^{14}N in this temperature range and in applied magnetic fields of 6340 to 13,000 Oe by the use of a Varian V-4210A spectrometer. The NMR signals were detected only in the dispersion mode and only by using high modulations and rf fields. The positive temperature-dependent Knight shift can be represented by $K = K_0 + \alpha\chi_M$, where $K_0 = -(31.5 \pm 3.5) \times 10^{-4}$ is different from the Knight shift, $+ (10.7 \pm 1.5) \times 10^{-4}$, of ^{14}N in isostructural ThN. The difference is probably due to some temperature-independent susceptibility of $\sim 10^{-3}$ cgs. The coefficient α is 4.20 + 0.25 (when χ_M is in cgs units), which is practically the same as α for other uranium compounds; α is analyzed on the assumption of U^{+4} ions ($5f^2$ configuration) and the recent value of 0.876 conduction electrons per uranium atom. In the model with uniform conduction-electron polarization, an exchange constant J_{sf} of − (1.0 ± 0.2) eV is obtained that has the same sign as in the lanthanides, but is about one order of magnitude larger; the variation is probably due to the larger extent of the 5f electronic functions. In the Ruderman−Kittel−Kasuya−Yosida (RKKY) model, the s-f coupling constant $\Gamma = -460$ eV Å^3 is again negative, but is about eight times higher than $|\Gamma|$ obtained from the paramagnetic Curie temperature ($\vartheta \simeq -320$°K) and the magnetic contribution to the resistivity. The variation of Γ is mainly due to the sensitivity of the RKKY sums, but also may be due to the simple RKKY model used. The constant value of α in uranium compounds, which have an ordered magnetic state, is an indication of the nonapplicability of the RKKY model to the analysis of the Knight shifts. The linewidth of ^{14}N in UN depends on the temperature and magnetic field. The linewidth is analyzed in terms of a constant quadrupole interaction (similar to that which contributes to the total linewidth in ThN) and a magnetic contribution that is proportional to $H_0/(T-\theta)$ (similar to that in UP with the quadrupole contribution absent). These results are compared with those on ^{14}N in lanthanide nitrides and with uranium compounds that have an ordered state. (auth)

27718 INTERFERENCE OF ELECTRONIC AND NUCLEAR RESONANCE ABSORPTION FOR MOESSBAUER E1 GAMMA RAYS. Trammell, G. T. (Technische Hochschule, Munich); Hannon, J. P. Phys. Rev., 180: 337-9(Apr. 10, 1969).

The large dispersion term in the absorption spectrum of the 6.25-keV ^{181}Ta γ ray which was found by Sauer, Matthias, and Moessbauer is interpreted as arising from the interference between nuclear absorption followed by internal conversion and photoelectric absorption. The interference is large because the nuclear transition is E1. (auth)

27719 MOESSBAUER EFFECT IN 7.2-yr ^{133}Ba. Boyle, A. J. F.; Perlow, G. J. (Argonne National Lab., Ill.). Phys. Rev., 180: 625-6(Apr. 10, 1969).

The Moessbauer effect was observed with the 12.29-keV transition in 7.2-yr ^{133}Ba. The absorber contained 0.75 mCi (2 μg) of the isotope. The source was 39-h^{133m}Ba. The absorber was a thin disk, 1.2 mm in dia. The source diameter was 1 mm and the mean separation 0.5 mm. A linewidth about three times natural was found with observed dips of 0.95% at 4.2°K and 0.34% at room temperature. (auth)

27720 RADIATION DAMAGE IN METALS. Res. Rev. (Office Aerosp. Res.), 7: No. 8, 11-12(Aug. 1968).

Experiments carried out on 3-MeV electron irradiation of platinum and palladium support the correlation of effective threshold energy with atomic number and lattice parameter for the fcc elements. It was also found that the electric resistivity per unit defect concentration can be correlated with the resistivity at 0°C. Use of an atomic cascade model, in which secondary displacements are inhibited, is discussed. (L.M.T.)

27721 THE OBSERVATION OF THE DIFFRACTION OF RESONANT RADIATION ON ELECTRONS AND NUCLEI IN 119Sn SINGLE CRYSTALS. Voitovetskii, V. K.; Korsunskii, I. L.; Novikov, A. I.; Pazhin, Ju. F. (Kurchatov Inst. of Atomic Energy, Moscow). Phys. Lett., 27A: 244-5(July 1, 1968).

The diffraction of resonant γ radiation in ^{119}Sn single crystals was investigated experimentally. The diffraction of resonant scattering on nuclei and the interference of resonantly scattered and electron scattered radiations was observed. (auth)

Theory

Refer also to abstract 27581.

Theoretical Physics

27722 AN OPERATIONAL INTERPRETATION OF NONRELATIVISTIC QUANTUM MECHANICS. Lamb, Willis E. Jr.

(Yale Univ., New Haven). Phys. Today, 22: No. 4, 23-8(Apr. 1969).

Idealized experiments are postulated to show that a physical measurement involves three stages: initial state preparation, perturbation, and examination for the probability that a particular final state is occupied. The physical system under study is a nonrelativistic spinless electron of mass m moving in a known conservative force field V(x). Classical state preparation, quantum-mechanical preparation, complications, spreading wave packets, dynamical variables, position coordinates, measuring Hermitian operators, and limitations of the method are discussed. (M.H.R.)

27723 NORMAL AND ABNORMAL DIFFUSION IN EHRENFESTS' WIND-TREE MODEL. Hauge, E. H. (Norges Tekniske Hoegskole, Trondheim); Cohen, E. G. D. J. Math. Phys. (N. Y.), 10: 397-414(Mar. 1969).

The Ehrenfest wind-tree model, a special case of the Lorentz model, where noninteracting point particles move in the plane through a random array of square scatterers, is used to study the divergences previously discovered in the density expansions of the transport coefficients. Two cases for which the results are qualitatively different are discussed. When the scatterers are not allowed to overlap, the diffusion of particles through the array of scatterers is normal, characterized by a diffusion constant D. The calculation of D^{-1} is carried to the second order in the density of the scatterers, and involves a discussion of the above-mentioned divergences and a resummation of all most divergent terms in the straightforward expansion of D^{-1}. If, however, the trees are allowed to overlap, the growth of the mean-square displacement with time is slower than linear, so that no diffusion coefficient can be defined. The origin and possible relevance of this new phenomenon to other problems in kinetic theory are discussed. The above results have stimulated molecular dynamics calculations by Wood and Lado on the same model. Their preliminary results seem to confirm the theoretical predictions. (auth)

27724 SYMMETRY OF THE GROUND-STATE WAVE FUNCTION OF MANY PARTICLE SYSTEM. Nagaoka, Yosuke; Usui, Tunemaru (Nagoya Univ., Japan). Progr. Theor. Phys. (Kyoto), Suppl. Extra No., 392-402(1968).

It is proved that, if the Hamiltonian of a system of spinless particles is symmetric with respect to interchange of the particles, the wave function with the lowest energy attainable without any restriction on its symmetry property, is symmetric with respect to interchange of the coordinates. Conditions that must be imposed upon the Hamiltonian for the theorem to be valid are also discussed. (auth)

27725 AN APPROXIMATION IN THE QUANTUM-MECHANICAL TREATMENT OF THE NONRELATIVISTIC THREE-BODY BOUND-STATE PROBLEM. Hori, Shoichi (Kanazawa Univ., Japan). Progr. Theor. Phys. (Kyoto), Suppl. Extra No., 80-96 (1968).

A new kind of coordinates are introduced to solve the Schroedinger equation for the nonrelativistic three-body problem. With these coordinates, the boundary conditions are simplified, especially for the cases in which the three particles are in the equilateral position and in which they are in the in-line position. The actual potential was replaced by a certain average of the potential, which still depends on one variable. Then the wave function can be separated into two parts: one which depends on a single variable and the other which is independent of the potential energy. The equation satisfied by the former wave function is reduced to the Morpurgo equation in the case of the ground state. The approximation can be improved with the aid of the perturbation theory, because the equations were derived without recourse to the variational calculation. (auth)

27726 INEQUALITIES FOR THE ENERGY AND FREE ENERGY OF MANY-BODY SYSTEMS. Kleban, Peter; Lange, R. V. (Brandeis Univ., Waltham, Mass.). Phys. Rev. Lett., 22: 1045-7(May 19, 1969).

The Bogolyubov inequality is employed to obtain bounds on the density dependence of the free energy and energy of a wide class of interacting many-particle systems, including the realistic case of multicomponent Coulomb-interacting systems. (auth)

27727 INTERPRETATION OF THE ENERGY-MOMENTUM TENSOR OF THE DIRAC FIELD. Gerlach, Bernd; Gromes, Dieter; Petzold, Joachim (Univ., Marburg, Ger.). Z. Phys., 221: 53-70(1969). (In German).

By comparing the structure of the particle current and of the energy and momentum density, the meaning of the various tensor components is clarified. The energy–momentum tensor is decomposed into two parts; one describes orbital, the other spin properties. (auth)

27728 NOTE ON THE DIRAC ELECTRON AND HIDDEN MOMENTUM FORCES. Van Vleck, J. H. (Harvard Univ., Cambridge, Mass.); Huang, N. L. Phys. Lett., 28A: 768-9 (Mar. 10, 1969).

The expressions for the force on a spin magnetic moment which is changing with time in the presence of an electric field are examined. The somewhat different results with the four-component Dirac as compared with the two-component Pauli scheme are discussed. (auth)

27729 HERMITE'S RECIPROCITY LAW AND THE ANGULAR-MOMENTUM STATES OF EQUIVALENT PARTICLE CONFIGURATIONS. Wybourne, B. G. (Univ. of Canterbury, Christchurch, N. Z.). J. Math. Phys. (N. Y.), 10: 467-71(Mar. 1969).

Hermite's reciprocity law is applied to the calculation of the angular-momentum states of equivalent particle configurations. Connections between boson and fermion states are considered and a method is given for determining the number of times a given term appears in l^3 without requiring a complete term analysis. A succinct expression for the number of S states arising in the $[2^2]$ representation of R_{2l+1} under $R_{2l+1} \rightarrow R_3$ is developed. (auth)

27730 AXIOMS OF MEASUREMENT THEORY. Krips, H. (Univ. of Adelaide). Nuovo Cim., 61B: 12-24(May 11, 1969).

An attempt is made to introduce the measurement process into the axioms of quantum mechanics. The most general density operator formalism is used; and the Born statistical interpretation is derived as a theorem, together with the hermitian nature of measurable operators. (auth)

27731 MEASURE-RELATIVE INFORMATION IN QUANTUM MECHANICS. Kossakowski, A. (Univ. of Torun, Poland). Bull. Acad. Pol. Sci., Ser. Sci. Math. Astron. Phys., 17: 77-9(1969).

In an earlier paper (Bull. Acad. Pol. Sci., Ser. Sci. Math. Astron. Phys., 16: 61(1968)) the author and R. S. Ingarden presented an axiomatic definition of information in quantum mechanics in terms of partial Boolean rings introduced by Kochen and Specker earlier. In this note, a measure-relative information (shortly μ-relative information) is defined as a natural generalization of the absolute information. Transformation properties of the μ-relative information with respect to unitary transformations in Hilbert space are investigated. (L.M.T.)

27732 THE POSSIBILITY OF FORMING, WITH THE BOUND STATE $l = 0$ OF THE HYDROGEN ATOM, A WAVE FUNCTION CORRESPONDING TO THE PERIODIC COLLISIONS OF THE ELECTRON ON THE NUCLEUS. Durand, Emile (Institut de Calcul Numerique, Toulouse). Compt. Rend., Ser. A, B, 267: 1198-91(Nov. 25, 1968). (In French).

It is known that if a wave bundle centered on a large quantum number is considered, the matrix element $\langle n + p|\vec{r}|n\rangle$ tends toward the p^{th} harmonic of the development of the classical motion in the Fourier series. This is one of the forms of the correspondence principle. (tr-auth)

27733 PHASE TRANSITION BETWEEN CONDENSED HOMOGENEOUS AND PERIODIC SYSTEMS. Coniglio, A.; Marinaro, M.; Preziosi, B. (CNR, Naples. Univ., Naples. Istituto Nazionale di Fisica Nucleare, Naples). Nuovo Cim., 61B: 25-46(May 11, 1969).

The properties of a many-body system exhibiting condensation both in a periodic state and in an homogeneous state are compared. The possibility of a transition between these two phases is discussed and explicitly shown to exist in a model. (auth)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Electromagnetic

Refer also to abstract 28208.

27734 (DESY-69/7) INELASTIC ELECTRON PROTON SCATTERING AT FIXED FOUR MOMENTUM TRANSFER OF 0.773 AND 1.935 (GeV/c)^2. Albrecht, W.; Brasse, F. W.; Dorner, H.; Flauger, W.; Frank, K.; Gayler, J.; Hultschig, H.; May, J.; Ganssauge, E. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Feb. 1969. 26p. Dep.

Inelastic e-p scattering measurements were performed at fixed four-momentum transfers of $q^2 = 0.773$ and 1.935 (GeV/c)^2 and at scattering angles of $\vartheta = 47.8°$ and 76.0° using the internal beam of the DESY electron synchrotron. Only the scattered electron was detected. The measured spectra ranged from pion threshold up to a missing mass of 3 GeV at $\vartheta = 47.8°$ and up to 2.6 GeV at I = 76°. The results are compared with predictions for inelastic e-p scattering. (auth)

27735 (NEVIS-170) THE DECAY BRANCHING RATIOS OF THE η^0 MESON. Kim, Jewan (Columbia Univ., Irvington-on-Hudson, N. Y. Nevis Labs.). Apr. 1969. Contract AT(30-1)-1932. 90p. (CU-274; R-664). Dep. CFSTI.

Thesis.

The decay branching ratios of the η^0 meson were measured. Combining these ratios with the measurement of ratio ($\eta^0 \rightarrow$ all neutral mode/$\eta^0 \rightarrow$ all charged mode) = 2.64 ± 0.23, the partial decay rates for the various η^0 decays are obtained. In particular, $(\eta^0 \rightarrow 3\pi^0)/(\eta^0 \rightarrow \pi^+\pi^-\pi^0) = 1.58 \pm 0.25$ was in good agreement with the assumption that the three-pion final state has I = 1. A fit was also made to the decay Dalitz plot of $\eta^0 \rightarrow \pi^+\pi^-\pi^0$ and $\eta^0 \rightarrow \pi^+\pi^-\gamma$. The linear matrix element and ρ-dominance model give the excellent fits to the decay Dalitz plots. For the mode $\eta^0 \rightarrow \pi^+\pi^-\pi^0$, b = −0.54 ± [illegible], where b is the slope in the spectrum of neutral pion kinetic energy. (auth)

27736 (NP-17880) MEASUREMENT OF NEUTRAL AND CHARGED PION FORM FACTOR SLOPES. Note No. 202. Devons, S.; Nemethy, P.; Nissim-Sabat, S. (Columbia Univ., New York); Di Capua, E.; Lanzara, A. (Rome Univ. (Italy). Istituto di Fisica. Istituto Nazionale di Fisica Nucleare, Rome (Italy)). Jan. 8, 1968. 29p. Dep.

In an experiment performed at Columbia University's Nevis Cyclotron the reactions $\pi^0 \rightarrow \gamma + e^+ + e^-$ (1) and $\pi^- + p \rightarrow n + e^+ + e^-$ (2) for π^- at rest were studied. Using a system of counters and spark chambers pairs with an opening angle near 120° were selected. The invariant mass spectrum of the pairs in 2200 π^0 decays (1) and in 400 radiative captures (2) was analyzed. For the π^0 form factor slope $a = (+0.01 \pm 0.11)/m_\pi^2$, was found. The charged pion form factor slope was obtained for time-like momentum transfers of the order of m_π. The result for the pion charge radius is $r_\pi < 1.9$ fermi with a 90% confidence level. (auth)

27737 ON THE POSSIBILITY OF INVESTIGATING PHOTONUCLEAR REACTION AT HIGH ENERGIES BY MASS SPECTROSCOPIC METHOD. Arshakuni, R. G.; Maloyan, A. G. Izv. Akad. Nauk Arm. SSR, Ser. Fiz., 3: 281-4(1968). (In Russian).

The possibility of measuring the cross sections of photonuclear reactions at high energies with multiple particle production by mass spectroscopic determination of small quantities (10^{-9}–10^{-14} g) of isotopes produced as a result of $A(\gamma,xn,yp)B$ type reactions is considered. (auth)

27738 STUDY OF (e^+e^-) PAIR PRODUCTION BY 1.25 TO 4 GeV ELECTRONS. Bem, Ya.; Grishin, V. G.; Muminov, M. M.; Strel'tsov, V. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 9: 580-6(Mar. 1969). (In Russian).

Cross section of (e^+e^-)-pair production by 1.25 to 4 GeV electrons is studied by means of a propane bubble chamber. The cross section obtained is in agreement with the theoretical value ($\sigma^T_{exp}/\sigma^T_e = 1.3 \pm 0.5$). Special methods to measure small distances in the bubble chamber were developed. (auth)

Weak

Refer also to abstract 27904.

27739 STUDY OF THE DECAY $K_2^0 \rightarrow 2\pi^0$. Kamae, Tuneyoshi. Princeton, N. J., Princeton Univ., 1968. 128p.

Thesis.

The ratio between the two decay rates, $\Gamma(K_2^0 \rightarrow 2\pi^0)/\Gamma(K_1^0 \rightarrow 2\pi^0)$, was studied by comparing the $2\pi^0$ decays in the K_2^0 beam to those in the regenerated K_1^0 beam. The advantage of this method is that the result is insensitive to detection efficiency. No free decays $K_2^0 \rightarrow 2\pi^0$ were observed above the $3\pi^0$ background. On the other hand, $2\pi^0$ decays of K_1^0 produced in the tungsten regenerator were clearly observed. The comparison of the free decay data with the regeneration data leads to the upper limit of 9.0×10^{-6} for this ratio. This corresponds to a value of $|\eta_{00}|$ which is consistent with 2.0×10^{-3} but less than 3.0×10^{-3} with 90% confidence. (auth)

27740 AN UPPER LIMIT ON THE DECAY RATE OF $K_L^0 \rightarrow \pi^+\pi^-\gamma$. Thatcher, Roy Cannon. Urbana, Ill., Univ. of Illinois, 1968. 78p.

Thesis.

In the film from a spark chamber experiment on K_L^0 decays performed in the 28° beam line of the ZGS at the Argonne National Laboratory, a search was undertaken for the decay mode $K_L^0 \rightarrow \pi^+\pi^-\gamma$. The charged decay products were momentum analyzed in a magnet and identified in a set of range-shower chambers on the basis of their behavior there. The position of the gamma ray conversion point in these chambers was compared with the position predicted on the hypothesis of $K_L^0 \rightarrow \pi^+\pi^-\gamma$. The $K_{\pi3}$ provided almost the sole background as well as the normalization of the rate measurement. In 962 events with good gamma showers one event was found that fitted the $\pi\pi\gamma$ hypothesis within the spacial resolution. However, the expected background was one event. This result corresponds to an upper limit on the decay rate $R(K_L^0 \rightarrow \pi^+\pi^-\gamma) \leq 7.5 \times 10^3$ sec^{-1} at a confidence level of 90%. The result is compared with the predictions of various theoretical models. The possible connections to other decay processes ($K^\pm \rightarrow \pi^\pm\pi^0\gamma$, $K_L^0 \rightarrow \pi^0\pi^0\gamma$, $K^0_S \rightarrow \pi^+\pi^-\gamma$) and the feasibilities of CP invariance tests are discussed. (Disser. Abstr.)

Strong (Baryon-Induced)

Refer also to abstracts 27797 and 27821.

27741 (NP-17873) LOW ENERGY $\bar{p}p$ ANNIHILATION INTO $\pi^+\pi^-$ AND K^+K^-. Internal Note No. 213. Bizzarri, R.; Guidoni, P.; Marzano, F.; Moneti, G. C.; Rossi, P.; Zanello, D. (Rome Univ. (Italy). Istituto di Fisica. Istituto Nazionale di Fisica Nucleare, Rome (Italy)); Castelli, E.; Sessa, M. (Trieste Univ. (Italy). Istituto di Fisica. Istituto Nazionale di Fisica Nucleare, Trieste (Italy)). Mar. 14, 1969. 11p. (In Italian). Dep.

Measurements were made of 117 $\bar{p}p \rightarrow \pi^+\pi^-$ events and 37 $\bar{p}p \rightarrow K^+K^-$ events with $\bar{p}$ momenta between 200 and 600 MeV/c. The π^- angular distribution has a striking forward peaking, which increases with decreasing $\bar{p}$ momentum. (auth)

27742 THE FOUR-PRONG ANNIHILATION OF 1.2 GeV/c ANTIPROTONS IN HYDROGEN III $K^+K^-\pi^+\pi^-$ AND $K^+K^-\pi^+\pi^-\pi^0$ FINAL STATES. Frodesen, A. G. (Univ. of Oslo); Skjeggestad, O.; Moore, R. S.; Reucroft, S. Nucl. Phys., B10: 307-18(1969).

From approximately 12,000 four-prong annihilations of 1.2 GeV/c antiprotons in hydrogen about 200 events involving two charged kaons were selected mainly on basis of ionization. The cross sections for the $K^+K^-\pi^+\pi^-$ and $K^+K^-\pi^+\pi^-\pi^0$ final states are 260 ± 40 μb and 290 [illegible] μb, respectively. The amounts of resonances produced have been estimated. The four-body final state is dominated by K*(890) production, whereas the five-body final state shows an abundant production of K*(890), ω(783), and ϕ(1019). (auth)

27743 DIFFERENTIAL CROSS SECTIONS FOR THE REACTIONS $p + p \rightarrow D + \pi^+$ AND $p + p \rightarrow D + \rho^+$ AT 21 GeV/c. Allaby, J. V.; Binon, F.; Diddens, A. N.; (and others). Phys. Lett., 29B: 198-202(Apr. 28, 1969).

Results are presented from an experiment in which high-energy deuterons, produced by proton-proton interactions at 21.1 GeV/c incident momentum, were detected over a range of angles from 12.5 mrad to 60 mrad in the laboratory system. From the momentum spectra of the deuterons, the final states $d + \pi^+$ and $d + \rho^+$ were identified. The angular distribution for these reactions are presented and compared with previous data at lower energies. (auth)

27744 STRONG DECAYS OF RESONANCES AND COUPLING CONSTANTS. Carbone, G. (Univ., Turin). Nuovo Cim., Lett., 1: 771-4(May 21, 1969).

An updating of tables published in November 1968 on strong decays of meson and baryon resonances is presented. The data and results quoted are the decay modes, the spin and parity, mass, total width, partial width, and the calculated values of the coupling constants. (L.B.S.)

27745 LOW-ENERGY $\bar{p}p$ ANNIHILATION INTO $\pi^+\pi^-$ AND K^+K^-. Bizzarri, R. (Univ., Rome. Istituto Nazionale di Fisica Nucleare, Rome); Guidoni, P.; Marzano, F.; Moneti, G. C.; Rossi, P.; Zanello, D.; Castelli, E.; Sessa, M. Nuovo Cim., Lett., 1: 749-52(May 21, 1969).

The total and differential cross sections were measured for the reactions $\bar{p}p \rightarrow \pi^+\pi^-$ and $\bar{p}p \rightarrow K^+K^-$ between 330 and 610 MeV/c. 223 events giving a kinematical fit to at least one of the two reactions were obtained from the Saclay 81 cm hydrogen bubble chamber. The following qualitative conclusions are drawn from the angular-distribution data: several partial waves are present in the $\pi^+\pi^-$ system around $\sqrt{s} \simeq 1890$ ($\sqrt{s}$ is the total cms-energy); the dominant ones must be nearly in phase to give such a strong asymmetry; and over a $\sqrt{s}$ interval of about 60 MeV this coherence is destroyed, possibly indicating a rapid variation of at least one phase. (L.B.S.)

Strong (Meson-Induced)

Refer also to abstracts 27736, 27744, and 27797.

27746 (BNL–13561) GUIDED TOUR OF "A_2". Lai, Kwan Wu (Brookhaven National Lab., Upton, N. Y.). Apr. 4, 1969. 36p. (CONF-690209–2). Dep. CFSTI.

From American Physical Society Meeting, New York.

A survey is first given of early bubble chamber experiments where the $A_2(1300)$ was evidenced as one peak. Results of new developments from counter experiments, which showed the two peak structure of A_2, are reviewed. Some implications and experimental evidence of $J^P(A_2^L = A_2^H)$ and $J^P(A_2^L \neq A_2^H)$ are given. Suggestions for further experiments are made. (L.B.S.)

27747 (COO-1428-117) STUDY OF $D^0 \rightarrow \pi^\pm\delta^\mp$ and $\delta^\mp \rightarrow \pi^\mp\eta$ IN THE REACTION $\pi^+d \rightarrow p_s pD^0$ AT 2.7 GeV/c. Campbell, J. H.; Lichtman, S.; Loeffler, F. J.; Miller, D. H.; Miller, R. J.; Miller, W. J.; Willmann, R. B. (Purdue Univ., Lafayette, Ind.). Apr. 1969. 12p. Dep. CFSTI.

In π^+d interactions at 2.7 GeV/c the D^0 meson was observed with mass 1.27 ± .01 GeV/c^2 and width 30 ± 15 MeV/c^2 to decay to the $\delta^\pm$ meson with mass .98 ± .01 GeV/c^2 and width 40 ± 15 MeV/c^2. The $\delta^\pm$ meson is further observed to decay into $\pi^\pm\eta$ with both neutral and charged decays of the η. (auth)

27748 (UCRL–18860) STUDY OF THE REACTIONS $K^-p \rightarrow p\bar{K}^0\pi^-$, $K^-p \rightarrow p\bar{K}^0\pi^0\pi^-$, AND $K^-p \rightarrow n\bar{K}^0\pi^+\pi^-$, FROM 2.1 TO 2.7 GeV/c. Friedman, Jerome H. (California Univ., Berkeley. Lawrence Radiation Lab.). Apr. 1969. Contract W-7405-eng-48. 311p. Dep. CFSTI.

Thesis.

The reactions $K^-p \rightarrow p\bar{K}^0\pi^-$, $K^-p \rightarrow p\bar{K}^0\pi^0\pi^-$, and $K^-p \rightarrow n\bar{K}^0\pi^+\pi^-$ are studied in detail in the LRL 72-in. hydrogen bubble chamber in the center-of-mass energy range 2.27 to 2.51 GeV. Total cross sections for these reactions as a function of center-of-mass energy are presented. Copious resonance production is observed in all of these final states. This resonance production is studied with the aid of a maximum likelihood technique and the relative rates of the well known resonances are presented as a function of center-of-mass energy. The differential cross section and decay correlation parameters are measured as a function of production angle and center-of-mass energy for the reaction $K^-p \rightarrow K^{*-}_{1/2}(892)$ p using the likelihood method. The differential cross section and parameters of the joint decay angular distributions for the double resonance production reaction $K^-p \rightarrow \bar{K}^*_{1/2}(892)\ N^*_{3/2}(1238)$ are also measured as a function of production angle and center of mass energy. The results of the analyses on the reactions $K^-p \rightarrow K^{*-}_{1/2}(892)$ p and $K^-p \rightarrow \bar{K}^*_{1/2}(892)\ N^*_{3/2}(1238)$ are compared to the predictions of the absorptive peripheral model, the Regge pole model, and the quark model. Finally, the $K\pi\pi$ mass spectra are studied and the structure therein discussed. (auth)

27749 INVESTIGATION OF QUASI-TWO-PARTICLE REACTIONS WITH PRODUCTION OF STRANGE PARTICLES IN π^-p INTERACTIONS AT 4.0 GeV/c. Kuznetsov, A. A.; Melnikova, N. N.; Chadraa, B.; Boldea, V.; Mikhul, A.; Mumuyanu, D.; Ponta, T.; Felea, S. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 9: 590–6(Mar. 1969). (In Russian).

Reactions $\pi^- + p \rightarrow \Lambda^0(\Sigma^0) + K^0$ and $\pi^- + p \rightarrow \Lambda^0(\Sigma^0) + K^{*0}_{890}$ are investigated at 4.0 GeV/c. Experimental data on total and differential cross sections of the reactions are presented. Production and decay properties of the $K^{*0}(890)$ resonance in $YK\pi$ final states are studied. The density matrix elements are calculated and the data are analyzed in framework of the peripheral model with absorption and of the Regge-pole model. (auth)

27750 COMPARISON OF LIFE-TIMES OF THE CHARGED PIONS. Petrukhin, V. I.; Rykalin, V. I.; Khazins, D. M.; Tsisek, Z. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 9: 571-9(Mar. 1969). (In Russian).

Life-times of the charged pions are compared in order to test the CPT theorem. The experiment is based on comparison of dampings of π^+ and π^- beams with 180-MeV/c momentum due to their decay in flight. Maximal variation of the flight basis was 6.84 m, that is 0.683 of the decay length for the π mesons with given momentum. The π mesons were identified and their velocity was measured by means of the time of flight spectrometer with the time resolution $2\tau = 0.65$ nsec. The value of life-time difference for the charged pions is obtained to be $\tau_+/\tau_- - 1 = (-0.14 \pm 0.29)\%$. (auth)

27751 INVESTIGATION OF THE REACTION $\pi^-p \rightarrow \pi^0n$ AT 4.0 GeV/c. Matulenko, J. (Joint Inst. for Nuclear Research, Dubna, USSR); Stavinski, V.; Hladky, J.; Lehraus, I.; Mokry, P.; Skura, J.; Szeptyckz, M.; Wojcik, W. Acta Phys. Pol., 35: 625-9 (Apr. 1969).

The reaction $\pi^-p \rightarrow \pi^0n$ at 4.0 GeV/c was analyzed using spark chamber technique. The cross section was found to be: $\sigma_{\pi^-p \rightarrow \pi^0n} = (0.130 \pm 0.020)$ mb. The ratio $X = |\mathrm{Re}\ T(t = 0)/\mathrm{Im}\ T(t = 0)| = 0.89 \pm 0.10$ corresponds, according to the Regge pole approach, to $\alpha_\rho(t = 0) = 0.46 \pm 0.06$. The comparison with theoretical prediction is presented. (auth)

27752 SEARCH FOR THE Z* IN $\pi^- + p \rightarrow K^- + Z^*$ AT 6 AND 8 GeV/c. Anderson, E. W. (Brookhaven National Lab., Upton, N. Y.); Bleser, E. J.; Blieden, H. R.; (and others). Phys. Lett., 29B: 136-9(Apr. 14, 1969).

A search was made for strangeness +1 baryons, Z*'s, in the reaction $\pi^- + p \rightarrow K^- + Z^*$. Peaks at missing masses of about 1590 MeV and 1950 MeV are interpreted as reflections of boson decays and upper limits have been assigned for Z* production. (auth)

27753 OBSERVATION OF THE $\mu^-\mu^+$ DECAY MODE OF THE η^0 MESON. Hyams, B. D. (CERN, Geneva); Koch, W.; Potter, D. C.; von Lindern, L.; Lorenz, E.; Luetjens, G.; Stierlin, U.; Weilhammer, P. Phys. Lett., 29B: 128-31(Apr. 14, 1969).

The rare decay mode of the η^0 meson into two muons was observed. The branching ratio for this decay mode is calculated using production cross sections from other experiments, and the result is compared with theoretical predictions. (auth)

27754 OMEGA AND ETA PRODUCTION IN $\pi^+d \rightarrow pp\pi^+\pi^-\pi^0$ AT 3.65 GeV/c. Benson, G. C.; Roe, B. P.; Sinclair, D.; Vander Velde, J. C. (Univ. of Michigan, Ann Arbor). Phys. Rev. Lett., 22: 1074-7(May 19, 1969).

Approximately 3000 examples of the reaction $\pi^+d \rightarrow pp\pi^+\pi^-\pi^0$ were observed and results are reported on ~300 events in which the $\pi^+\pi^-\pi^0$ mass is in the ω^0 mass region and ~40 events in the η^0 mass region. Differential cross sections are presented. There is evidence for a backward peak in the overall channel. Values are given for the ω^0 density-matrix elements in the forward direction. The value for $\mathrm{Re}\rho_{10}$ is negative, in disagreement with various theoretical models. (auth)

27755 PRODUCTION MECHANISM OF SOME 6 GeV/c K^-p INTERACTIONS. Paler, K. (Imperial Coll. of Science and Tech., London); Chadhuri, P.; Sisterton, L. K.; Eskreys, A. W.; Lyons, L.; Finney, P. J. Nucl. Phys., B10: 221-32 (1969).

Various three-body final states produced in 6 GeV/c K^-p interactions show peripheral features. These are examined in some detail, and it is found that a double peripheral mechanism is consistent with the data. For each reaction when interpreted in this way the most important double peripheral process is one in which the final state pion is produced at the central vertex. Two-dimensional transfer distributions are analyzed; it is found that the strongest dependence on momentum transfer occurs when the relevant initial and final state particles are identical. (auth)

27756 EVIDENCE FOR AN I = 0, J = 0 $K^0\bar{K}^0$ STATE. Hoang, T. F. (Argonne National Lab., Ill.): Nuovo Cim., 61A: 325-31 (May 21, 1969).

A two-channel S-matrix analysis of K_1K_1 threshold enhancement of CERN and Argonne experiments indicates the existence of an I = 0, J = 0, $K^0\bar{K}^0$ state with a binding energy ~80 MeV and rules out the S*(1068) resonance. (auth)

27757 DISTRIBUTION OF TRANSVERSE AND LONGITUDINAL MOMENTUM IN π^-p INTERACTIONS AT 7.0 GeV/c. Ijaz, M. A.; Campbell, J. E. (Virginia Polytechnic Inst., Blacksburg, Va.). Nuovo Cim., 61A: 307-19(May 21, 1969).

Measurements were made of the p_t and p_l spectra of the pions and protons produced in six- and two-prong interactions in a bubble-chamber experiment. The BNL 80 in. liquid-hydrogen bubble chamber was exposed to a 7.0 GeV/c negative-pion beam. The data are analyzed in terms of the Hagedorn model and the two-temperature model of Wayland and Bowen. The temperature of the interaction volume obtained from fitting the p_t spectra of the pions is below 140 MeV, and for the protons it is close to 180 MeV. The p_l spectra of the pions yields a good fit to an expression given in the two-temperature model. The six-prong data were divided into peripheral and nonperipheral events and the temperature values of the two samples show considerable difference for the proton p_t distributions. Data were obtained from the other experiments at different energies. It is found that the temperature increases with the rise in incident-particle energy, and it decreases as the multiplicity of the pions produced increases at a fixed incident energy. (auth)

Particle Interactions and Properties (Theoretical)

General

27758 (AD–677336) RESEARCH IN ELEMENTARY PARTICLE PHYSICS. Final Scientific Report, April 1, 1966–March 31, 1968. Ne'eman, Y. (Tel Aviv Univ. (Israel). Dept. of Physics). June 15, 1968. 22p. (TAUP–47-68; AFOSR–68-2313). CFSTI.

A summary is given of the research performed under the grant. Results include important advances in the description of high-energy phenomena, extensions of the group theoretical methods, and studies of a model explaining the CP-violation in the long-lived component of the $K^0\bar{K}^0$ system. A list of the 29 papers generated under the grant is included; and a paper entitled "Algebraic Methods in Particle Physics" is appended. (USGRDR)

27759 ON A POSSIBILITY OF MEASURING THE ENERGY OF RELATIVISTIC PARTICLES BY MEANS OF TRANSITION RADIATION. Ispiryan, K. A.; Oganesyan, A. G. (Inst. of Physics, Erevan). Izv. Akad. Nauk Arm. SSR, Ser. Fiz., 3: 290-3(1968). (In Russian).

The angular distribution of the intensity of transition radiation of relativistic particles in the region of the optical frequencies is considered. It is shown that the sharp dependence of the intensity of radiation emitted into a certain angular interval may be used for measuring the energy of the high energy particles. (auth)

27760 SOLUTION OF THE BETHE–SALPETER EQUATION WITH A SQUARE-WELL POTENTIAL. Keam, R. F. (Univ. of Auckland, N. Z.). J. Math. Phys. (N. Y.), 10: 594-603(Apr. 1969).

The ladder approximation Bethe–Salpeter equation for a bound spin-0 boson–boson system of zero total mass and a bound spin-½ fermion–antifermion system of zero total mass is solved for a four-dimensional square-well potential. (auth)

27761 UPPER BOUND FOR ELEMENTARY PARTICLE RADIUS AND LOWER BOUND FOR THEIR FORM FACTOR. Baluni, V.; Nguyen Van Hieu; Suleimanov, V. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 9: 635-9 (Mar. 1969). (In Russian).

Using analytical properties of form factors, an upper bound for the elementary particle radius and restriction from below on the form factor decrease at negative momentum transfers, are obtained. (auth)

27762 INTEGRAL REPRESENTATIONS OF RELATIVISTIC PHASE SHIFTS. Krori, K. D. (Cotton Coll., Gauhati, India). Indian J. Pure Appl. Phys., 7: 145-7(Mar. 1969).

Integral expressions were derived by the Wronskian methods for the phase shifts and the phase shift differences in the case of Klein–Gordon and Dirac particles. Conditions in the nonrelativistic limit were also discussed. (auth)

27763 STUDY OF DIFFERENT ASPECTS OF DIRAC EQUATION AT HIGH ENERGIES. Krori, K. D. (Cotton Coll., Gauhati, India). Indian J. Pure Appl. Phys., 7: 148-50(Mar. 1969).

Formulations of the Dirac equation were studied: θ-equation; r-equation; integral representation of wave equation; phase shift; and phase shift difference. The results of the study were discussed in the light of previous results. (auth)

Electromagnetic

27764 (DESY–69/10) VECTOR MESON DOMINANCE AND PHOTOPRODUCTION. Schildknecht, D. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Feb. 1969. 35p. Dep.

The vector meson dominance model of photoproduction is reviewed with an emphasis on the most recent results. (auth)

27765 (NP-17871) MULTIPLE SCATTERING CORRECTIONS TO HIGH ENERGY π^+ PHOTOPRODUCTION. Internal Note No. 211. Benfatto, G.; Nicolo, F.; Rossi, G. C. (Rome Univ. (Italy). Istituto di Fisica). Mar. 12, 1969. 11p. Dep.

The Frautschi–Margolis model for generating multiple scattering corrections in the form of Regge cuts is extended to the π^+ photoproduction, obtaining for the high energy differential cross section a very good agreement with experimental data up to $|t| \simeq 0.8\ (\mathrm{GeV/c})^2$. (L.B.S.)

27766 (SLAC-PUB–571) THEORETICAL IDEAS ON HIGH-ENERGY INELASTIC ELECTRON–PROTON SCATTERING. Bjorken, J. D. (Stanford Linear Accelerator Center, Calif.). Mar. 1969. 16p. (CONF-690209–1). Dep. CFSTI.

From American Physical Society Meeting, New York.

Various features of the data on inelastic electron-proton scattering at 7 to 18 GeV reported by the MIT-SLAC group are examined. Other possible experiments which may exhibit scale-invariance or point like behavior at high transverse momentum are first discussed. Three theoretical descriptions of the data are then discussed: (1) the incoherent scattering from pointlike constituents within the proton; (2) vector dominance, or Rutherford electron; and (3) current commutators. Finally, the implications of these models are discussed for future electron and muon scattering experiments such as electron scattering from deuterium, separation of σ_t from σ_l, the A-dependence of electron scattering from nuclei, and the nature of the final hadron states in these processes. (L.B.S.)

27767 (SLAC-PUB–589) HIGH ENERGY PHOTOPRODUCTION AND ELECTROPRODUCTION. Gilman, Frederick J. (Stanford Linear Accelerator Center, Calif.). Apr. 1969. 47p. (CONF-690316–1). Dep. CFSTI.

From Conference on Particle Interactions at High Energies, Toronto, Canada.

A review is given of some of the recent experimental and theoretical developments in the field of high energy photoproduction and electroproduction. The topics covered include pion photoproduction, vector dominance model, sign of $\pi^0 \rightarrow \gamma\gamma$ decay amplitude, vector meson photoproduction, multibody photoproduction, and high energy electroproduction. (L.B.S.)

27768 (UCSD–10-P-10-57) PROTON–PROTON BREMSSTRAHLUNG. Burnett, Thompson Humphrey (California Univ., La Jolla, San Diego). [1968]. Contract AT-11-1-GEN-10. 76p. Dep. CFSTI.

A covariant formulation of nucleon-nucleon bremsstrahlung is presented which is unitary, gauge invariant and has a relatively simple form in the soft-photon limit. Applying the soft-photon approximation to experiment, a large discrepancy is found with noncoplanar data taken in the Harvard geometry, while the fit for the coplanar case is good. The inclusion of nonsoft-photon dynamics using S-matrix methods is discussed. (auth)

27769 FIELD OF CHARGE ENTERING INTO GYROTROPIC FERROMAGNETIC MEDIUM. Mergelyan, O. S. (Inst. of Physics, Erevan). Izv. Akad. Nauk Arm. SSR, Ser. Fiz., 3: 285-9(1968). (In Russian).

The radiation of a charged particle entering into a gyrotropic ferromagnetic medium is calculated. Formulas for the frequency spectrum and for the polarization of the radiation in vacuum are obtained. (auth)

27770 ENERGY LOSS OF PARTICLE PASSING UNDER AN OBLIQUE ANGLE THROUGH A PLATE. Garibyan, G. M.; Elbakyan, S. S. (Inst. of Physics, Erevan). Izv. Akad. Nauk Arm. SSR, Ser. Fiz., 3: 244-53(1968). (In Russian).

The total energy losses of relativistic particle passing through a plate under an oblique angle are calculated. Conditions are obtained for the thickness of the plate and for the particle incident angle, in the case of the realization for which the logarithmic dependence of the losses upon the particle energy will be conserved. (auth)

27771 RADIATION OF A POINT-PARTICLE IN THE WAVEGUIDE WITH GYROTROPIC FERRITE. Gazazyan, E. D.; Laziev, E. M.; Pogasyan, E. S. (Inst. of Physics, Erevan). Izv. Akad. Nauk Arm. SSR, Ser. Fiz., 3: 254-9(1968). (In Russian).

The Vavilov–Čerenkov radiation of a point-particle in the waveguide with gyrotropic ferrite in a constant magnetic field directed along the direction of axis of the waveguide is considered. Expressions for the radiation intensity of the left-handed and right-handed polarization waves are obtained. The analysis of the dispersion equation is performed. (auth)

27772 ELECTRON IN A GIVEN TIME-DEPENDENT ELECTROMAGNETIC FIELD. Capri, Anton Z. (Princeton Univ., N. J. Univ. of Alberta, Edmonton). J. Math. Phys. (N. Y.), 10: 575-80(Apr. 1969).

The theory of a quantized Dirac field interacting with a classical electromagnetic field is considered. The resulting q-number problem is reduced to a closely related c-number problem. The theory is then shown to be without divergences. The interpolating field is shown to exist and is local. Also, the S matrix is shown to be unitary. (auth)

27773 $K^* \rightarrow K\gamma$ DECAY AND RADIATIVE CORRECTIONS TO THE K-MESON β DECAY. Musakhanov, M. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 9: 611-15(Mar. 1969). (In Russian).

It is shown that the requirement for the radiative correction to the K-meson β decay to be finite results in a sum rule involving electromagnetic and weak ($\Delta S = 0$) transitions of the K meson. The form factor of the $K^* \rightarrow K\gamma$ decay is calculated with the $K^*(890)$ meson as the only intermediate state. (auth)

27774 HYPERGEOMETRIC DIFFERENCE EQUATIONS AND COULOMB RELATIVISTIC PROBLEM. Kadyshevskii, V. G.; Mir-Kasimov, R. M.; Friman, M. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 9: 646-52(Mar. 1969). (In Russian).

Finite difference analogues for the hypergeometric functions are presented, and the equations satisfied by these functions are obtained. The obtained results are used to find the exact solution of the Coulomb problem in framework of the quasipotential approach. (auth)

27775 SUM RULES FROM THE FIELD ALGEBRA FOR ρ^0-MESON PHOTOPRODUCTION. Lazarenko, L. A.; Soroka, V. A. (Physical-Technical Inst., Kharkov). Yadern. Fiz., 9: 623-8 (Mar. 1969). (In Russian).

Sum rules for the reaction $\gamma + p \rightarrow p + \rho^0$ are found and their convergence is studied. The possible saturation of the obtained sum rules by resonance states is discussed. (auth)

27776 SOLUTION OF THE RELATIVISTIC QUANTUM EQUATION FOR AN ELECTRON IN A COULOMB FIELD. Arzhanykh, I. S.; Shaibaev, E. B. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat., No. 5, 25-9(Sept.-Oct. 1968). (In Russian).

The problem concerning the integration of the relativistic quantum equation in a Coulomb field is resolved. The method of decomposition of the unknown function in a series according to the Compton wavelength is proposed. The eigenvalues are decomposed into a similar series. The solution was obtained in explicit form for two approaches. (tr-auth)

27777 PHOTOPRODUCTION OF THE HYPERNUCLEI $_\Lambda He^4$ AND $_\Lambda H^4$. Sidorov, A. A. (Tomsk Polytechnical Inst., USSR). Yadern. Fiz., 9: 510-14(Mar. 1969). (In Russian).

Cross section of the reactions $\gamma + {}^4He \rightarrow K^0 + {}_\Lambda He^4$ and $\gamma + {}^4He \rightarrow K^+ + {}_\Lambda H^4$ are calculated in the momentum approximation. The calculations are made with the Gauss wave functions for ^4He and hypernuclei. The expressions obtained from the analysis of the experimental data were used for the amplitude of K and Λ photoproduction on nucleons. (auth)

27778 STATIC MULTIPOLE MOMENTS OF $\Delta_{1236}(^3/_2, {}^3/_2)$ FROM SUPERCONVERGENCE IN $N\gamma \rightarrow \Delta\pi$ SCATTERING. Schiller, D. H. (Univ. of Timisoara, Rumania); Raszillier, I. Z. Phys., 222: 425-38(1969).

Saturating superconvergence sum rules in $N\gamma \rightarrow \Delta\pi$ scattering by N and Δ, one is able to relate the (isoscalar) dipole magnetic moment $\overline{\mu}_\Delta$ and the quadrupole electric moment $\overline{Q}_\Delta$ of the isobar Δ to the electric charge $\overline{Z}_N$ and the dipole magnetic moment $\overline{\mu}_N$ of the nucleon N. The numerical results are: $\overline{\mu}_\Delta \equiv \mu_{\Delta^+} + \mu_{\Delta^0} = 3.26$ (in units e/2M) = 2.48 (in units e/2m), and $\overline{Q}_\Delta \equiv Q_{\Delta^+} + Q_{\Delta^0} = 0.050$ (in units e/M^2) = 0.029 (in units e/m^2), where M(m) is the mass of Δ(N). Neglecting the pion mass and taking $M = m$, $\mu_n/\mu_p = -^2/_3$, one gets the SU_6 result $\mu_{\Delta^+} = \mu_p$. (auth)

27779 BACKWARD SINGLE PION PHOTOPRODUCTION AND THE SYMMETRIC QUARK MODEL. Copley, L. A.; Karl, G.; Obryk, E. (Oxford Univ.). Phys. Lett., 29B: 117-20(Apr. 14, 1969).

The contribution of baryonic resonances to the differential cross sections for single pion photoproduction in the backward direction is calculated using the quark model. The absence of peaks due to the $D_{13}(1520)$ and the $F_{15}(1680)$, and the presence of $I = {}^3/_2$ peaks in photoproduction from protons is explained. Differential cross sections for photoproduction from neutrons are predicted. (auth)

27780 INELASTIC ELECTRON-NUCLEON SCATTERING AND THE POMERANCHUK SINGULARITY. Harari, Haim (Weizmann Inst. of Science, Rehovoth, Israel). Contract F-61052-68-C-0070. Phys. Rev. Lett., 22: 1078-81(May 19, 1969).

It is suggested that the amplitude for virtual Compton scattering at large spacelike photon masses is completely dominated at all energies by the Pomeranchukon exchange or diffraction mechanism and that all the contributions of s-channel N^* resonances and "ordinary" t-channel exchanges decrease rapidly with q^2. Experimental and theoretical implications of this conjecture are discussed. (auth)

27781 ON THE PHOTON RADIATION AT TWO-PARTICLE ANNIHILATION OF POLARIZED ELECTRON-POSITRON PAIR. Nagorskaya, I. A.; Khoze, V. A. (Moscow State Univ.). Izv. Akad. Nauk Arm. SSR, Ser. Fiz., 3: 371-7(1968). (In Russian).

Using the method of invariant tensor integration the polarization contribution to the exact cross sections for emission of a photon in two-particle annihilation of an arbitrary polarized electron-positron pair is calculated. An analysis of the results obtained is carried out. (auth)

27782 $A_1\rho\pi$-VERTEX AND PRODUCTION OF A_1-MESON IN COLLIDING BEAMS. Matinyan, S. G.; Shakhnazaryan, Yu. G. (Inst. of Physics, Erevan). Izv. Akad. Nauk Arm. SSR, Ser. Fiz., 3: 366-70(1968). (In Russian).

The production of the A_1-meson in colliding beams ($e^- + e^+ \rightarrow A_1 + \pi$) is investigated using a precise vertex $A_1\rho\pi$ obtained previously and the idea of vector dominance. (auth)

27783 MASS OF KAPPA MESON FROM SPECTRAL FUNCTION SUM RULES. Acharya, R. (Univ., Bern). Nucl. Phys., B10: 208-12(1969).

A modified form of the second Weinberg sum rule is proposed for strangeness-changing vector and axial-vector currents. Together with the first sum rule, it is used to predict the kappa mass. The estimate is compared with the value obtained from chiral symmetry considerations of Glashow and Weinberg. (auth)

27784 PHOTON-NUCLEUS ELASTIC AND TOTAL CROSS SECTIONS. Margolis, B.; Tang, C. L. (McGill Univ., Montreal). Nucl. Phys., B10: 329-38(1969).

The forward scattering amplitude and hence the total cross section for photons incident on nuclei is calculated in the eikonal approximation. The scattering amplitude is taken to be the sum of two types of coherent amplitudes; (a) elastic scattering from each nucleon and (b) a regenerative amplitude corresponding to the production of the vector mesons ρ, ω, and φ on one nucleon and radiative capture on another. A considerable effect due to the finite mass of the vector mesons is seen at energies up to 10 GeV in heavy nuclei. This manifests itself as an apparent violation of vector dominance for the photon-nucleus interaction which disappears at very high energies if vector dominance is valid for the photon-nucleon interaction. (auth)

27785 SPECTRAL FUNCTION SUM RULES FOR TENSOR CURRENTS AND THE ρ-MESON ELECTROMAGNETIC MASS DIFFERENCE. Cook, P. A. (Univ. of Kent, Canterbury, Eng.); Joshi, G. C. Nucl. Phys., B10: 253-60(1969).

From the validity of equal-time commutation relations of the vector and the antisymmetric tensor currents, spectral function sum rules are derived which relate the spectral functions of vector currents to the spectral functions of the antisymmetric tensor currents. Saturation of these sum rules with single particle states is discussed. These sum rules are then used to calculate the electro-magnetic mass splitting of the ρ-meson, with the result that ρ^0 is predicted to be heavier than $\rho^\pm$. (auth)

Weak

Refer also to abstract 27838.

27786 (CALT-68-186) ANGLE IN WEAK INTERACTIONS. Cabibbo, N. (California Inst. of Tech., Pasadena). Jan. 1969. Contract AT(11-1)-68. 13p. (CONF-690110-1). Dep. CFSTI.

From Conference on Fundamental Interactions at High-Energy, Coral Gables, Fla.

Some recent work is reported on the problem of determining the weak interaction angle by imposing a self-consistency condition on weak, strong, and electromagnetic forces. (L.B.S.)

27787 (NP-17872) RADIATIVE CORRECTIONS TO THE LEPTON POLARIZATION AND TO THE RATE IN K_3 DECAY. Internal Note No. 208. Benfatto, G.; Nicolo, F.; Rossi, G. C. (Rome Univ. (Italy). Istituto di Fisica). Mar. 10, 1969. 24p. Dep.

Radiative corrections to the lepton polarization and to the rate in K_{l3} decay are calculated. They are found to be very small and for the rate strongly cutoff dependent. (auth)

27788 (NP-17889) β-DECAY OF HYPERONS. Internal Note No. 212. Marchioro, C.; Prosperetti, A.; Pugliese, A. (Rome Univ. (Italy). Istituto di Fisica). Mar. 13, 1969. 22p. Dep.

The β-decay of hyperons is studied in the framework of the current × current theory of weak interactions. Results are expressed in a manageable form for experimental purposes. Numerical calculations are performed for the Λ and Σ^- decays and informations obtainable from experiments are discussed. (auth)

27789 WEAK MASS SPLITTINGS. Rawls, John M. (Brandeis Univ., Waltham, Mass.). Nucl. Phys., B10: 323-8(1969).

The lowest order contributions to weak mass splittings of soft pseudoscalar mesons are calculated using the SU(3) × SU(3) algebra. The most divergent terms cancel in all cases considered; in the special case of the Cabibbo theory, the mass splittings vanish identically. (auth)

27790 ARE THERE HEAVY LEPTONS? Rothe, Kenneth W.; Wolsky, Alan M. (Univ. of Pennsylvania, Philadelphia). Nucl. Phys., B10: 241-6(1969).

Theoretical and experimental evidence is considered for the existence of a lepton (analogous to the muon or electron) whose mass is greater than the muon. It is found that theory cannot exclude such a particle. Presently available data show that such a lepton must be heavier than the kaon. (auth)

Strong (General)

27791 ISOSPIN CROSSING MATRIX. Lee, Huan (Univ. of California, Berkeley). J. Math. Phys. (N. Y.), 10: 779-87 (Apr. 1969).

New properties and relations to Clebsch–Gordan coefficients were found and proved for a certain subset of isospin crossing matrix elements. These properties, coupled with the well-known fact that the crossing matrix is simply related to a real orthogonal matrix, provide a quick method to calculate crossing matrices of rank ≤4. Procedures of construction and tables are given for all crossing matrices involving $I \leq \frac{3}{2}$. For the sake of completeness as well as clarification of the confusing point about phases, a systematic discussion of crossing relations and a general expression for crossing matrices applicable to arbitrary phase conventions are included. For the crossing matrix in which both direct and crossed reactions are elastic, some interesting inequalities among elements in the first and last columns are noticed and their physical implication is briefly discussed. (auth)

27792 SPECTROSCOPIC PHENOMENOLOGY OF BARYONS AND BOSONS CONSIDERED AS DISCRETE QUANTIZED STATES OF AN INTERNAL STRUCTURE OF ELEMENTARY PARTICLES. Depaquit, Serge; Vigier, Jean-Pierre (Institut Henri Poincare, Paris). Compt. Rend., Ser. B, 268: 657-9(Mar. 3, 1969). (In French).

If one considers the baryon and boson resonances as quantized states of a system governed by a global dynamic group (uniting internal and external symmetries) it is natural to say that bosons are the particles emitted when the system passes from one quantum state to another. At the time of a strong transition between baryon (fermion) levels the emitted particles are characterized by boson quantum numbers. So the intermediate bosons emitted play a role analogous to photons emitted in the usual spectral transitions. Experiment seems to confirm the fact that the difference of the masses between the initial and final levels is(to about several megaelectron volts) equal to the mass of the intermediate boson or bosons emitted during the quantum transition considered. (tr-auth)

27793 THE MULTI-REGGE MODEL AND STRANGE-PARTICLE PRODUCTION. Murro, O. (Univ., Bari, Italy); Selleri, F. Nuovo Cim., Lett., 1: 784-8(May 21, 1969).

The intrinsic probability for production of a $K\bar{K}$ pair ($P_{K\bar{K}}$) in high energy interactions is calculated according to the multi-Regge model. It is predicted that $P_{K\bar{K}}$ should decrease like $E^{-1/4}$. This decreasing behavior confirms the qualitative expectation and disagrees with experiments. (L.B.S.)

Strong (Baryon No. = 0)

Refer also to abstract 27803.

27794 FINITE-ENERGY SUM RULES WITH THE CHENG REPRESENTATION. Karpf, A. D. (Univ., Freiburg i. B.). Z. Phys., 222: 462-73(1969).

The unitary Cheng representation for the partial wave amplitudes is adopted to calculate the left-hand side of a FESR in the $\pi\pi$-system. The results confirm the nonsense choosing mechanism for the ρ-meson and give a hint for t-dependence of the remaining residuum function $\beta(t)$. (auth)

27795 LORENTZ EXPANSION FOR THE VENEZIANO AMPLITUDE. Di Vecchia, P.; Drago, F.; Ferrara, S. (CNEN, Frascati, Italy). Contract F 61052-67-C-0084. Phys. Lett., 29B: 114-16(Apr. 14, 1969).

The Veneziano amplitude is projected on the irreducible representations of the Lorentz group. An infinite sequence of Toller poles, as well as an essential singularity as $\lambda \to \infty$, is shown to be present. Fixed poles at the non positive integers are also present. The residues of the Toller poles, with the exception of the first, do not factorize. (auth)

27796 POSITIVE DOUBLE SPECTRAL FUNCTIONS ARE INCOMPATIBLE WITH THE EXISTENCE OF THE f(1260) RESONANCE. Yndurain, F. J. (CERN, Geneva). Phys. Lett., 29B: 125-7(Apr. 14, 1969).

It is shown that the existence and the known properties of the 2^+, I = 0 f(1260) resonance make it very unlikely that the double spectral functions $\rho(s,t)$ of the Mandelstam representation for the isospin-zero $\pi\pi$ scattering amplitude be positive. In particular, Atkinson's parametrization $\rho = \rho_{\text{elastic}} + \rho_{\text{inelastic}}$ with $\rho_{\text{inelastic}} \geq 0$ is completely ruled out. (auth)

27797 INTERACTION CROSS SECTIONS OF ELEMENTARY PARTICLES. Barashenkov, V. S. Hartford, Conn., Daniel Davey and Company, Inc., 1969. 423p. $21.50. (IPST-Cat.-2191).

Translation of Secheniya Vzaimodeistvii Elementarnykh Chastits by Y. Oren.

The experimental and theoretical results for the interaction cross sections of various particles are presented. These results cover nucleon, antinucleon, hyperon, and meson interactions. Meson (π)–nucleon interactions, the interactions of meson (K) with nucleons, the classification of resonances, and cross sections at very low energies are included. Also threshold anomalies, the one-particle approximation, and asymptotic properties of cross sections are discussed. (J.F.P.)

27798 LOW-ENERGY PION–PION PARAMETERS FROM FORWARD DISPERSION RELATIONS. Morgan, D.; Shaw, Graham (Rutherford High Energy Lab., Chilton, Eng.). Nucl. Phys., B10: 261-82(1969).

Values of the $\pi\pi$ scattering lengths and low-energy phase shifts are tabulated corresponding to various assumptions on the mass and width of the sigma meson. The method uses forward and first derivative dispersion relations. The I = 0 S-wave scattering length α_0 comes out in the range –0.3 to 0.6 m_π^{-1}. The P- and D-wave scattering lengths are relatively independent of the sigma parameters. Solutions are compared with results on K_{e4} decay and with the predictions of current algebra. Super broad sigmas seem to be preferred. Such solutions are also more self consistent in a bootstrap sense. (auth)

27799 ELASTIC SCATTERING AND ISOBAR PRODUCTION AT HIGH ENERGIES. Jacob, M.; Pokorski, S. (CERN, Geneva). Nuovo Cim., 61A: 233-48(May 21, 1969).

Unitary corrections to Regge-pole amplitudes, as they may be introduced using the Baker–Blankenbecler formalism, are used in the analysis of the structure of differential cross sections at small and intermediate transfers. (auth)

Strong (Baryon No. = 1)

Refer also to abstracts 27756, 27799, and 27878.

27800 (ITF-69-5) THE MODEL OF A NEUTRAL PION-NUCLEON NONRENORMALISED INTERACTION WITHOUT ULTRA-VIOLET DIVERGENCES. Volkov, M. K. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1969. 20p. (In Russian). (CONF-680949-6). Dep.

From 2nd Conference on Statistical and Physical Kinetics, Ukrainian, SSR.

A new form of writing for the interaction Lagrangian in the neutral pseudoscalar theory with the pseudovector bond is suggested. The finite model with the unitary S-matrix is constructed by the help of it and a new method of transition to the momentum space. (auth)

27801 (NP-17870) STATISTICAL MODEL CALCULATION OF THE BRANCHING RATIOS OF N*(1470). Abramovici, A.; Vekas, L. (Timisoara Univ. (Romania). Dept. of Physics). Jan. 1969. 7p. Dep.

A statistical model was used to obtain the branching ratios of N*(1470). The ratios found agree with those obtained by other methods. Considering that the $\sigma(410)$ dipion resonance does not exist, a branching ratio of 0.637 was found for the elastic channel very near to that obtained in other papers. This supports the nonexistence of $\sigma(410)$. Further, these calculations show that N^{*+++} (1470) with $T = {}^5\!/_2$ decays mainly via Δ^{++}. (auth)

27802 (NP-17887) CONSTRAINTS ON REGGE-POLE PARAMETERS FROM A NEW FAMILY OF DISPERSION SUM RULES. Internal Note No. 204. Lusignoli, M.; Restignoli, M.; Violini, G. (Rome Univ. (Italy). Istituto di Fisica). Jan. 22, 1969. 9p. Dep.

Integrating over a finite energy region the forward dispersion relations, a family of sum rules are derived which provide constraints for the scattering amplitude asymptotic behavior. These sum rules are applied to the pion-nucleon scattering. (auth)

27803 APPLICATION OF THE Z = 0 CONDITIONS TO DESCRIPTION OF THE ρ MESON AND THE N*(1240) RESONANCE. Braun, M. A. (Leningrad State Univ.). Yadern. Fiz., 9: 629-31 (Mar. 1969). (In Russian).

Masses and widths of the ρ meson and the N*(1240) resonance are calculated in framework of the self-consistent method, based on the conditions $Z_1 = Z = 0$ for the renormalization constants. (auth)

27804 SUPERCONVERGENT SUM RULES FOR MESON-BARYON SCATTERING AND J-PLANE SINGULARITIES. Kwiecinski, J. (Inst. of Nuclear Physics, Krakow). Acta Phys. Pol., 35: 535-48(Apr. 1969).

The possible superconvergent relations which correspond to the decouplet exchange in the t-channel are considered for meson-baryon scattering. The following combination of scattering amplitudes is used in the analysis of sum rules: $T_{10} = T_{\pi^-p} - T_{\pi^+p} + T_{K^+p} - T_{K^-p} + T_{\bar{K}^*p} - T_{K^*p}$. It is found that the superconvergence relations hold for nonspin-flip but fail for the spin-flip amplitudes. It is suggested that the failure of the latter may be due to the j-plane branch point singularity which protects the fixed singularity at the wrong signature nonsense point j = 0. It is argued by means of the many channel unitarity condition that this branch point singularity is likely to be absent at t-channel partial wave helicity amplitudes, which are regular at j = 0. Thus it does not prevent the sum rule for the nonspin-flip amplitude from holding. (auth)

27805 MODIFIED PHASE SPACE MODEL AND ITS APPLICATION IN FITTING EFFECTIVE MASS DISTRIBUTIONS IN MANY-BODY REACTIONS. Otwinowski, S. (Inst. of Nuclear Research, Warsaw). Acta Phys. Pol., 35: 603-23(Apr. 1969).

A modified phase space model with a matrix element depending on baryon momentum is presented for πp interactions. The predictions of the model are shown to agree with the experimental effective mass distributions of pionic subsystems in the reactions $\pi^+p \rightarrow p5\pi$ and $\pi^+p \rightarrow p6\pi$ at 8 GeV/c. The production of mesonic resonances is estimated. (auth)

27806 $(\Sigma_\alpha, \Sigma_\gamma)$ REGGEIZED BARYON EXCHANGE MODEL FOR BACKWARD $\pi^-p \rightarrow K^0\,\Lambda$ SCATTERING. Barger, V.; Cline, D.; Matos, J. (Univ. of Wisconsin, Madison). Contract AT(11-1)-881. Phys. Lett., 29B: 121-4(Apr. 14, 1969). COO-881-226).

The backward scattering angular distribution and Λ polarization for the reaction $\pi^-p \rightarrow K^0\Lambda$ are successfully described by a Reggeized baryon exchange model with $(\Sigma_\alpha, \Sigma_\gamma)$ exchange-degenerate trajectories. The zero of the experimental polarization and the change in slope of $d\sigma/du$ near $u \approx -0.7\ (GeV/c)^2$ are correlated with a wrong-signature nonsense zero of the Σ_γ amplitude at $\alpha = -{}^3\!/_2$. (auth)

27807 EMPIRICAL N/D POTENTIAL AND CASTILLEJO-DALITZ-DYSON POLES IN THE PION-NUCLEON P_{11} STATE. Bart, George R.; Warnock, Robert L. (Illinois Inst. of Tech., Chicago. Argonne National Lab., Ill.). Phys. Rev. Lett., 22: 1081-4(May 19, 1969).

The CERN phase-shift analysis is used to evaluate the left-cut term of the P_{11} partial wave of pion-nucleon scattering. The inelastic N/D equation is solved with this term and the elasticity η as input. The output and input phase shifts agree below 2 BeV if and only if at least two Castillejo-Dalitz-Dyson poles are included in the canonical D function. This result rules out single-channel bootstrap models and furnishes a constraint on many-channel models. (auth)

27808 MODEL FOR ELASTIC HADRON SCATTERING AT HIGH ENERGIES. Azimov, S. A.; Arushanov, G. G.; Gulyamov, U. G.; Yuldashev, A. A.; Khalmuradov, R. S. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk, No. 4, 39-42(1968). (In Russian).

A model of elastic hadron scattering at high energy describing experimental data for small and large momentum transfer was used for interpreting π^-p scattering at 8 GeV and large momentum transfer. An attempt was also made of correlating the model to the existing experimental data on π^-p and pp scattering at high energies and arbitrary momentum. (R.V.J.)

27809 SUPERCONVERGENT DISPERSION RELATIONS AT VARIABLE MASSES. Ghika, G.; Radescu, E. E. (Inst. of Atomic Physics, Bucharest). Nucl. Phys., B10: 247-52(1969).

The Fubini-Furlan on-shell formula for πN s-wave scattering lengths is rederived, in the isotopic odd case from a superconvergent sum rule for weak amplitudes, without using explicitly current commutators. The basic assumption is that $p_\mu p_\nu (T^A_{\mu\nu} - T^V_{\mu\nu})$ approaches zero as $x \rightarrow \infty$ faster than x^{-1}. The $T^A_{\mu\nu}$ and $T^V_{\mu\nu}$ are respectively the weak axial vector and vector-nucleon scattering amplitudes. X denotes the Fubini-Furlan dispersion variable related to both energy and mass, and p is the nucleon momentum. (auth)

27810 FIT TO K*(890)N PRODUCTION BY MEANS OF REGGEIZED HELICITY AMPLITUDES. Markytan, M. (CERN, Geneva). Nucl. Phys., B10: 193-207(1969).

The energy and the momentum transfer dependences of the differential cross sections and spin density matrix elements of the reactions $K^-p \rightarrow K^{*-}_{890}\,p$, $K^-p \rightarrow K^{*0}_{890}\,n$, and $K^+p \rightarrow K^{*+}_{890}\,p$ are simultaneously fitted with a model of Reggeized helicity amplitudes involving P, P′, $\omega(\Phi)$, A_2, π, and ρ exchange. (auth)

27811 REGGEIZATION OF KINEMATICALLY FREE AMPLITUDES. Osborne, P. M.; Taylor, J. C. (Oxford Univ.). Nucl. Phys., B10: 213-20(1969).

A differential technique is used to generate Reggeized scattering amplitudes, satisfying all kinematic constraints and factorization, parametrized in terms of kinematically free residue factors. There is a unique prescription for retaining non-singular leading terms, which are the same as the leading terms of Toller poles of classes I and II. Certain zeros at t = 0, usually deduced from factorization, appear automatically. The relation to elementary particle exchange is explicit, and questions of gauge invariance are readily treated. Examples from $\pi N \rightarrow \Delta\pi$, $\pi N \rightarrow \Delta\rho$, and $\gamma N \rightarrow N\pi$ are given. (auth)

27812 CHARGE-SYMMETRY VIOLATING EFFECTS OF THE PHOTON-PION EXCHANGE PROCESS IN Λ-N INTERACTION. Leung, J. S. (Univ. of Victoria, British Columbia). Nucl. Phys., B10: 233-40(1969).

Exchange of a photon and a pion together gives rise to charge asymmetry in the Λ-N interaction. The Λ-N potential due to this exchange process is evaluated. It is found that the charge symmetry violating part of the photon-pion exchange potential is much weaker than that of the π^0-exchange process due to Σ-Λ mixing, for distances larger than 1 fm. (auth)

27813 MODIFIED LORENTZ-POLE ANALYSIS OF SOME SCATTERING AND REACTION AMPLITUDES. Bedford, D. (Australian National Univ., Canberra). Nucl. Phys., B10: 410-18(1969).

A modification to the normal O(3,1) analysis of high-energy amplitudes is introduced, and single pole, single j_0 value contributions to the differential cross sections for $pp \rightarrow pp$, $\pi p \rightarrow \pi p$, $\pi^-p \rightarrow \pi^0 n$, $\pi N \rightarrow \omega N^*$, $\pi N \rightarrow \eta N^*$, $N\overline{N} \rightarrow Y\overline{Y}$ are calculated and compared with experimental data. The agreement is fairly good; in particular, the dips appear very naturally at the right t values. (auth)

27814 THE MASS AND WIDTH OF THE $N^*_{\frac{3}{3}}$ RESONANCE FROM QUANTUM FIELD THEORY WITHOUT CUT-OFF. Rodei, L. B. (Umea Univ., Sweden). Nucl. Phys., B10: 419-30(1969).

From the usual relativistic pseudoscalar Hamiltonian a model Hamiltonian for low-energy pion-nucleon scattering is derived which is a generalization of the static model to take into account the recoil of the nucleon. An approximate expression is derived for the elastic low-energy pion-nucleon scattering amplitude by making a partial summation to infinite order of the perturbation expansion of the resolvent operator. The amplitude obtained converges after coupling constant renormalization in the infinite momentum cut-off limit. Determining the value of the coupling constant by requiring the theory to reproduce the experimental scattering length one obtains $g^2/4\pi = 23.25$ giving 1368 MeV for the mass and 260 MeV for the width of the N* resonance. (auth)

27815 CONTRIBUTION OF N AND Δ EXCHANGED REGGE TRAJECTORIES TO HIGH-ENERGY BACKWARD MESON-BARYON SCATTERING. Noirot, Y.; Rimpault, M.; Saillard, Y. (Faculte des Sciences, Bordeaux). Nucl. Phys., B10: 368-74 (1969).

Backward differential cross sections of high energy meson–baryon scattering is computed with the exchange of the N and Δ Regge trajectories in the u-channel. Residues are supposed to be connected by unitary symmetry. The available experimental values of the differential cross sections though providing some indications are insufficient to give a decisive test of our model. (auth)

27816 O(3,1) SYMMETRY AND ASSOCIATED PRODUCTION REACTIONS. Samiullah, M.; Rao, A. Srinivas (Osmania Univ., Hyderabad, India). Nucl. Phys., B10: 390-8(1969).

The high-energy behavior of the associated production reactions $\pi^+p \rightarrow K^+\Sigma^+$, $K^-p \rightarrow \pi^-\Sigma^+$, $\pi^-p \rightarrow K^0\Sigma^0$, $\pi^-p \rightarrow K^0\Lambda^0$ were analyzed within the framework of the O(3,1) symmetry based on the Delbourgo, Salam, Strathdee formalism. It is found that the exchanged particles in these reactions K^* and K^{**} belong to the families $j_0 = 0$, $j_0 = 1$, $\eta\xi = +1$ and $j_0 = 0$. $\eta\xi = +1$ and with the degeneracy hypothesis their trajectories are given in terms of $\alpha_{K^*} \equiv \alpha_{K^{**}} = \sigma_{K^*,K^{**}}-1$. Our results are in fair agreement with experimental data. (auth)

27817 REMARKS ON THE MINAMI SYMMETRY AND A NEW SYMMETRY RELATION FOR THE BARYON TRAJECTORIES. Saleem, M. (Panjab Univ., Lahore). Nuovo Cim., 61A: 320-4(May 21, 1969).

The Minami symmetry about the α octet and γ octet trajectories for baryons is reviewed. From phenomenological study a relation connecting the slopes and J (W = 0) of the two types of trajectories is proposed and on the basis of this relation, predictions about the masses and J^P values of some resonances are made. (auth)

27818 ISOBARS SHARING THE QUANTUM NUMBERS OF THE NUCLEON. Halzen, F.; Minkowski, P. (Univ. of Louvain, Belgium). Nuovo Cim., Lett., 1: 789-97(May 21, 1969).

The P_{11} channel in πN scattering is investigated under the hypothesis that a sequence of isobars or daughters of the nucleon Regge trajectories governs the amplitude both in the background region in the crossed channel at high energies and in the direct channels for low energies. Resonances are predicted in the P_{11} channel at the energies W = 1.78, 2.07, 2.33, . . . GeV. It is concluded that daughter trajectories will continue to materialize into resonances as long as the nucleon trajectory continues to rise (i.e., up to $s = 3\ \text{GeV})^2$) if N*(1688) is taken to be the last nucleon resonance. (L.B.S.)

27819 EFFECT OF TWO-MESON CUT ON $Y_1^*(1385)$ PRODUCTION IN $\pi\mathcal{N}$ INTERACTIONS. Singh, C. P.; Agarwal, B. K. (Allahabad Univ., India). Nuovo Cim., Lett., 1: 756-60(May 21, 1969).

The contribution of a two-meson (πK) exchange in the t-channel to the $\pi + N \rightarrow Y_1^* + K$ interaction is estimated on the basis of a rescattering square diagram, and is found to account for the forward and backward peaking and the variation of cross section with energy. (L.B.S.)

Strong (Baryon No. ≥ 2)

Refer also to abstracts 27799, 27813, 27878, and 28269.

27820 (ITEF–620) YIELDS OF K-MESONS, ANTIPROTONS, AND OTHER SECONDARY PARTICLES IN PROTON-NUCLEUS INTERACTIONS ON VARIOUS TARGETS AT ENERGIES OF 6 TO 10 GeV (SURVEY). Tsukerman, I. S. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1968. 40p. (In Russian). Dep.

This survey gathers together published data on the production of charged K-mesons and antiprotons during proton–nucleus interactions on various targets when the kinetic energy of the protons ranges from six to ten GeV. Some data are also given on the yields of π-mesons and other secondary particles at various energies. Formulas and graphs are given in the appendix for theoretical evaluation of the yields of secondary particles. (auth)

27821 (LA–4143) INTERACTIONS OF NUCLEONS WITH DEUTERONS, TRITONS, ^{3}He, OR ^{4}He BETWEEN 30 MeV AND 1 GeV: A BIBLIOGRAPHY. Seagrave, John D.; Jackson, Betty S. (comps.) (Los Alamos Scientific Lab., N. Mex.). Mar. 15, 1969. Contract W-7405-eng-36. 41p. Dep. CFSTI.

A bibliography of nucleon interactions with deuterons, tritons, helium-3 and helium-4 between 30 MeV and 1 GeV is presented. This bibliography was obtained from a search of Nuclear Science Abstracts. An author index is also provided. (J.F.P.)

27822 THE RATIO OF NONMESIC TO π^--MESIC DECAY OF LIGHT HYPERFRAGMENTS. Chaudhari, K. N. (Tata Inst. of Fundamental Research, Bombay); Ganguli, S. N.; Rao, N. K.; Swami, M. S.; Gurtu, A.; Singh, M. B. Proc. Indian Acad. Sci., Sect. A, 69: 78-87(Feb. 1969).

A new method of obtaining the charge spectrum of light hyperfragments from their residual range distribution is described. This method was used to determine the ratio (Q^-) of nonmesic to π^--mesic decay of light hyperfragments. The values of Q^- for hyperfragments of different charges are found to be in good agreement with theoretical calculations of Dalitz. (auth)

27823 INELASTIC PROCESSES AT HIGH ENERGIES AND PROBLEM OF NUCLEAR CROSS SECTIONS. Gribov, V. N. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz., 9: 640-5(Mar. 1969). (In Russian).

Energy and impact parameter distributions are analyzed in the region of very high energies assuming processes with large momenta to be not essential, quasielastic processes to be described by the Pomeranchuk pole exchange. It is shown that at asymptotically nonaccessible energies, when the increasing with the energy interaction radius which corresponds to the Pomeranchuk pole exchange becomes more than the nuclear radius, the cross section of interaction of nucleon with nuclei remains proportional to $A^{1/3}$ and the cross sections of interaction of two nuclei are proportional to $A^{4/3}$. (auth)

27824 ΛN AND ΛΛ INTERACTIONS AND STRUCTURE OF HYPERNUCLEI. Zhukov, M. V.; Khrylin, B. A. Yadern. Fiz., 9: 507-9(Mar. 1969). (In Russian).

Parameters for the ΛN and ΛΛ interactions are obtained from the data on bound energies of $_\Lambda He^4$, $_\Lambda He^5$, and $_{\Lambda\Lambda}He^6$. A possibility is discussed of the existence of the hypernuclei multiplet states, due to the approximate equality of the singlet and triplet ΛN-interaction potential. (auth)

27825 METHODS OF SEPARATION OF NUCLEAR REACTION CHANNELS IN THE EXPOSURE OF A BUBBLE CHAMBER TO THE 2 TO 10 GeV NEUTRON BEAM. Moroz, V. I.; Nikitin, A. V.; Troyan, Yu. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 9: 565-70(Mar. 1969). (In Russian).

Methods to separate the channels of reactions in the np interactions in 3- and 5-prong stars produced in a 24 liter propane bubble chamber exposed to the 2 to 10 GeV neutron beam, are considered. The separation is based on the χ^2 method and on the study of limiting kinematics using some probable considerations on the effective masses of the secondary particles. As a result, a sufficient separation of the reaction channels for given neutron exposure is obtained. Present methods allow one also to estimate the most probable neutron momentum in the given interaction act. (auth)

27826 EFFECTS OF NUCLEON STRUCTURE AND HIGH-ENERGY PHENOMENA ON LOW-ENERGY N–N SCATTERING. Thevenet, Christiane (Univ., Lyon), J. Phys. (Paris), 30: 148-52(Feb.-Mar. 1969). (In French).

The analysis of data on N–N elastic scattering at low energies is usually made by assuming that the five independent amplitudes are dominated by the exchange of the low lying meson resonances as π, ρ, ω, σ, η, and φ. This method gives good results when the distance between nucleons is not too small ($r \geq 0.4$ fm), while for $r < 0.4$ fm a "hard core" is used. In place of an arbitrary hard core description a modification of the propagators associated with the exchange of the different particles, in such a way as to have consistency with the high energy experimental data is proposed. (auth)

27827 FORM FACTORS, N–N OBEP, AND L^2 INTERACTIONS. Ueda, T.; Green, A. E. S. (Univ. of Florida, Gainesville). Nucl. Phys., B10: 239-98(1969).

Higher order regularization techniques and their implications or equivalences in terms of nucleon-meson form factors are considered. Concentration is given to the case of a meson field which is regularized to an order equivalent to the use of a dipole form factor. The one boson exchange potentials associated with such a model are examined. The inclusion of an L^2 interaction is studied and it is found that such terms lead to further improvement in fits. The nucleon-meson form factors are compared with those for inelastic N-N scattering and the electromagnetic form factor. (auth)

27828 GLAUBER SHADOW AND INELASTIC CONTRIBUTIONS TO πd SCATTERING. Alberi, G. (Univ., Trieste, Italy). Nuovo Cim., 61A: 203-14(May 21, 1969).

The contribution of inelastic intermediate states in the elastic πd scattering is estimated using a Regge-pole model. It is shown that this effect can fill the dip which otherwise should be present in the differential cross section. (auth)

27829 COMPUTATION OF FORWARD pp DISPERSION RELATIONS. Pascual, P.; Yndurain, F. J. (CERN, Geneva). Nuovo Cim., 61A: 225-32(May 21, 1969).

Forward pp dispersion relations are computed by expanding the unphysical part in a series of Chebyshev polynomials, and fitting the coefficients to the experimental low-energy values of Re f_{pp}. The fit is very good and the results are consistent with experiment when extrapolated at high energy. As a by-product, values of real and imaginary parts of the $\bar{p}p$ amplitude at zero energy are obtained. (auth)

27830 PRODUCTION OF ALIGNED DEUTERONS IN HIGH-ENERGY ELASTIC PROTON-DEUTERON SCATTERING. Harrington, D. R. (Rutgers-The State Univ., New Brunswick, N. J.). Phys. Lett., 29B: 188-90(Apr. 28, 1969).

It is shown that, because of spin-dependence resulting from the D-wave components of the deuteron, it should be possible to produce and analyze strongly aligned beams of high-energy deuterons by elastic scattering on protons. (auth)

Particle Invariance Principles and Symmetries

General

Refer also to abstract 27760.

27831 FINITE TRANSFORMATIONS OF SU(3). Holland, Douglas Francis (Univ. of Arizona, Tucson). J. Math. Phys. (N. Y.), 10: 531-5(Mar. 1969).

The properties of SU(3) finite transformations are investigated. These transformations on the defining three-dimensional complex space are parameterized in a form employing three factors, two of which are the Euler parameterization of an SU(2) subgroup. The irreducible representations of the factored parameterization are found explicitly. The volume element is calculated and the orthogonality relation is verified. Spherical harmonic basis states are derived as a specialization of the transformation matrix. Another result is a definition of triality and a simple proof that it is additive modulus three. (auth)

27832 PARTIAL-WAVE ANALYSIS IN TERMS OF SL(2,C)/SU(2) HARMONIC FUNCTIONS. Maduemezia, Awele (International Centre for Theoretical Physics, Trieste, Italy). J. Math. Phys. (N. Y.), 10: 519-23(Mar. 1969).

A new scheme for analyzing the scattering amplitude in the s channel of a two-body elastic collision in terms of the representation functions of the covering group of the homogeneous Lorentz group is presented. The scheme uses representation functions defined on the homogeneous space SL(2,C)/SU(2), which for the equal-mass case considered here is the same as the hyperquadric $q^2 - q_0^2 = -m^2$, where m is the particle mass, q is the relative center-of-mass momentum (in the initial or final state), and $2q_0 = s^{1/2}$ is the center-of-mass energy. The corresponding representations are multi-valued and belong to the so-called degenerate (but not most-degenerate) series. The scattering amplitude derived has the correct threshold behavior in the s variable. (auth)

27833 UNITARY REPRESENTATIONS OF THE POINCARE GROUP CONTAINED IN A CLASS OF REPRESENTATIONS OF THE CONFORMAL GROUP. Klink, William H. (Univ. of Iowa, Iowa City). J. Math. Phys. (N. Y.), 10: 606-13(Apr. 1969).

A unitary irreducible class of representations of the conformal group is constructed and reduced with respect to the Poincaré group to see which unitary irreducible representations of the Poincaré group it contains. In particular, it is shown that this class of representations of the conformal group does not contain the continuous-spin representations of the Poincaré group. It is concluded that the representations of the conformal group cannot be used to eliminate the continuous-spin representations. (auth)

27834 REGGE TRAJECTORIES AND SO(4) SYMMETRY. Savel'ev, M. V.; Fedoseev, I. A. (Inst. of High Energy Physics, Serpukhov, USSR). Yadern. Fiz., 9: 632-4(Mar. 1969). (In Russian).

Regge trajectories for two-particle backward scattering are considered by means of the Bethe—Salpeter equation in the generalized ladder approximation. Their classification in SO(4) symmetry is given. Analytical properties at u = 0 are given. In particular, for the scalar case the absence of the branch point is shown. (auth)

27835 NONCONSERVED VECTOR CURRENTS AND CP VIOLATION. Jouvet, Bernard (College de France, Paris). Compt. Rend., Ser. B, 268: 709-12(Mar. 10, 1969). (In French)

The necessary consideration of phantom poles of null mass vector field propagators of the nonet in interaction with nonconserved hadron currents leads one to postulate the existence of a nonet of scalar fields of null mass whose proper couplings violate C. The consequences of this theory are discussed. (tr-auth)

27836 GENERAL STRUCTURE OF MULTIPLETS FOR MASSLESS PARTICLES. Ferrari, R. (Univ., Pisa, Italy). Nucl. Phys., B10: 375-89(1969).

The structure of the multiplets is analyzed for massless particles, when one combines the internal symmetry group with the inversion operators T, P, and θ. The technique of the irreducible corepresentations is used for the extended group. Only the extension of the symmetry group that contains the time reversal gives non-trivial classification for the multiplets and three types are found. Examples are given in terms of fields. (auth)

Applications (Electromagnetic and Weak)

27837 (CALT-68-187) CERTAIN THEORIES OF CP-VIOLATION. Gell-Mann, Murray (California Inst. of Tech., Pasadena). Jan. 1969. Contract AT(11-1)-68. 10p. (CONF-690110-2). Dep. CFSTI.

From Conference on Fundamental Interactions at High-Energy, Coral Gables, Fla.

Attempts to explain CP violation are classified into three classes of theories. Theories of fairly large CP violation at moderate energies are classified into two types — where large CP violating effects are restricted to reactions involving certain new particles and where large CP violating effects occur in reactions involving familiar reactions. A few possibilities which concern the hypothetical intermediate vector boson for weak interactions, which might be connected with CP violations in theories of these types are discussed. (L.B.S.)

27838 (NP-17888) T-VIOLATION IN HYPERON β-DECAY. Internal Note No. 206. Marchioro, C.; Prosperetti, A.; Pugliese, A. (Rome Univ. (Italy). Istituto di Fisica). Jan. 29, 1969. 10p. Dep.

Some consequences of T-violation in Λ and Σ^- β-decays are studied, together with a possible simulation of such an effect by final state electromagnetic interactions. The conclusion is that within a wide experimental range there is no possibility of confusing the two sources of an observed T-odd correlation. By use of a model of CP-violation through second class currents, an upper bound for the T-violating effect is given. Experimental possibilities of testing this model are briefly discussed. (auth)

27839 P- AND T-PARITY VIOLATIONS IN RESONANCE SCATTERING OF GAMMA RADIATION. Belyakov, V. A.; Orlov, V. P. Zh. Eksp. Teor. Fiz., 56: 1366-74(Apr. 1969). (In Russian).

Resonance scattering of γ-radiation by nuclei in a magnetic field is considered. Expressions for the scattering amplitudes and cross sections of a mixed multiplicity nuclear transition are derived for the case when the line width of the incident γ-radiation is smaller than the Zeeman splitting of the nuclear levels. The scattering cross section is expressed in terms of resonance absorption cross sections in the Zeeman transitions. Consequences of violation of P- and T-parity in resonance scattering of γ-quanta are analyzed. Scattering in nuclear transitions which are a mixture of dipole and quadrupole multipoles is considered in detail. (auth)

27840 ELECTROMAGNETIC CURRENT IN THE UNITARY SYMMETRY. Gubar, Yu. I. (Moscow State Univ.). Yadern. Fiz., 9: 616-22(Mar. 1969). (In Russian).

A method to describe properties of symmetry recently proposed for the mass operator is applied to the electromagnetic current. It is supposed that the simple symmetrization of the current operator reduces it to a SU(2)-invariant type. The symmetrized current turns out to be also SU(3) invariant and, in particular, can be zero operator. Relations between the electromagnetic form factors for members of the same unitary multiplet are obtained. Sum rules for radiative decays of decuplet baryons and vector nonet mesons are derived. A general expression for the current is obtained. The formulas obtained, taking into account unitary symmetry violations, generalize those already known or coincide with them. The method permits transparent interpretation. (auth)

27841 EXPERIMENTAL EVIDENCE AGAINST PARTICLE MIXTURE MODELS OF CP VIOLATION. Darriulat, P.; Deutsch, J. P.; Kleinknecht, K.; Rubbia, C.; Tittel, K. (CERN, Geneva). Phys. Lett., 29B: 132-5(Apr. 14, 1969).

Predictions of particle mixture models which propose to preserve CP invariance at the price of an additional long-lived kaon state with CP = +1 are found in disagreement with interference experiments on two pion decays. (auth)

27842 A CONSEQUENCE OF T VIOLATION IN K_{l3} DECAY. Kenny, B. G. (Rutherford High Energy Lab., Chilton, Eng.). Nuovo Cim., Lett., 1: 746-8(May 21, 1969).

The discrepancy that exists between experimental determinations of the parameter ξ in K_{l3} decay is examined. The consequence of a complex ξ is illustrated. (L.B.S.)

Applications (Strong)

27843 REALIZATION OF CHIRAL SYMMETRY IN A CURVED ISOSPIN SPACE. Meetz, Kurt (Univ., Bonn). J. Math. Phys. (N. Y.), 10: 589-93(Apr. 1969).

The nonlinear realizations of the chiral group SU(2) ⊗ SU(2) are studied from a geometric point of view. The three-dimensional nonlinear realization, associated with the pion field, is considered as a group of coordinate transformations in a three-dimensional isospin space of constant curvature, leaving invariant the line element. Spinor realizations in general coordinates are constructed by combined coordinate–spin-space transformations in analogy to Pauli's method for spinors in general relativity. The description of vector mesons and possible chiral-invariant Lagrangians, which yield the various nonlinear models in specific frames of general coordinates, are discussed. (auth)

27844 SCALAR MESONS AND THE BREAKING OF SU(3). Krolikowski, W. (Inst. for Nuclear Research, Warsaw. Warsaw Univ.). Acta Phys. Pol., 35: 655-7(Apr. 1969).

An argument is given to support the theorem that the divergences of the strangeness-changing vector currents, if considered to the first order of magnitude in the medium strong interactions, are proportional to scalar fields belonging to 8_D of SU(3). (auth)

27845 METRIC STRUCTURES AND CHIRAL SYMMETRIES. Isham, C. J. (Imperial Coll. of Science and Tech., London). Nuovo Cim., 61A: 188-202(May 21, 1969).

Various aspects of nonlinear-group realizations are discussed and it is shown that the nonlinear $SU_3 \times SU_3$ chiral-invariant meson Lagrangian, and hence the meson-meson low-energy processes can be expressed completely in terms of the canonical metric on the group space of SU_3. (auth)

Field Theories

Quantum Field Theory

Refer also to abstracts 27553, 27814, and 27882.

27846 (DESY-69/9) FIELDS, OBSERVABLES, AND GAUGE TRANSFORMATIONS. [PART] I. Doplicher, Sergio (Aix-Marseilles Univ. (France). Faculte des Sciences. Deutsches Elektronen-Synchrotron, Hamburg (West Germany)); Haag, Rudolf; Roberts, John E. (Hamburg Univ. (West Germany). Institut fuer Theoretische Physics (II)). Feb. 1969. 32p. Dep.

Starting from an algebra of fields f and a compact gauge group of the first kind G, the observable algebra a is defined as the gauge invariant part of f. A gauge group of the first kind is shown to be automatically compact if the scattering states are complete and the mass and spin multiplets have finite multiplicity. Under reasonable assumptions about the structure of f it is shown that the inequivalent irreducible representations of a ("sectors") which occur are in one-to-one correspondence with the inequivalent irreducible representations of G and that all of them are "strongly locally equivalent." An irreducible representation of a satisfies the duality property only if the sector corresponds to a 1-dimensional representation of G. If G is Abelian the sectors are connected to each other by localized automorphisms. (auth)

27847 (DESY-69/13) EFFECTIVE LAGRANGIANS AND FIELD ALGEBRAS WITH CHIRAL SYMMETRY. Gasiorowicz, S.; Geffen, D. A. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Mar. 1969. 166p. Dep.

A review is made of the recent developments of effective Lagrangians and field algebras as means of treating chiral symmetry and PCAC. The techniques employed are developed in considerable detail. As examples, spin-0 and -1 linear and nonlinear realizations of SU(2) × SU(2) and SU(3) × SU(3) are considered and some of the significant predictions of the theory are derived. An extensive discussion is given of an effective Lagrangian with nonets of real scalar, pseudo-scalar, vector, and axial-vector mesons that illustrate the problems of broken SU(3) × SU(3). (auth)

27848 (IFA-FT-72) ELECTRODYNAMICS OF MOVING MEDIA AND THE THEORY OF RELATIVITY. Ionescu-Pallas, N. J. (Academia R. P. R., Bucharest. Institutul de Fizica Atomica). 1968. 19p. (In Rumanian). Dep.

The electrodynamics of moving bodies is derived in a covariant form by using the concept of "Q-vector" (complex three-dimensional vector the square of which is a Lorentz invariant). The dynamical characterization of a Q-vector leads—by virtue of some simple and reasonable assertions—to the field equations of the conventional theory. As concerns the equations of the material, the conclusion is quite different. The standard approach, in which the electrical permeability (ϵ), the magnetical permeability (μ) and the electrical conductivity (λ) are considered as some four-scalars is proved to be in conflict with relativity theory. In order to overcome this difficulty, the insertion into electrodynamics of a four-vector of resistivity is proposed. After this completion, the relaxation time ($\epsilon/4\pi\lambda$) behaves under a change of the inertia frame according to the prescriptions of relativity theory. Thus, the electrodynamics of moving media becomes a relativistic theory not only by its covariant form but also by the conclusions derived from it. Finally, support for the four-vector of resistivity is achieved from relativistic thermodynamics. (auth)

27849 (ITF-69-3) MODEL OF LOCAL THEORY WITH DISTURBED CAUSALITY. Medvedev, B. V.; Pavlov, V. P.; Sukhanov, A. D. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1969. 8p. (In Russian). Dep.

The model with a quantum vector field is constructed. The model contains a unitary S-matrix. The Lagrangian is local: the fields are locally commutative, but the causality in Bogolyubov's sense is disturbed. (auth)

27850 (N-69-14808) THE MAXIMUM NUMBER OF BINARY COLLISIONS FOR THREE RELATIVISTIC POINT PARTICLES. Doolen, G. (National Aeronautics and Space Administration, Greenbelt, Md. Goodard Space Flight Center). May 1968. 14p. (NASA-TM-X-63423; X-641-68-205). CFSTI.

As a step toward understanding relativistic rescattering singularities n_{max}, the maximum number of binary collisions allowed by special relativity among three particles with zero-range forces is examined. It is found that for three equal-mass particles n_{max} = 3 but for three particles with masses $m_1 = m_3 = 1$ and $m_2 = m < 1$, n_{max} decreases with increasing total energy, W, and finally attains the value of four when $W > 1/m$. (auth)

27851 BOUND STATES OF A NEW KIND IN QUANTUM FIELD THEORY. Zimmerman, Robert L. (Univ. of Oregon, Eugene). J. Math. Phys. (N. Y.), 10: 509-18(Mar. 1969).

The various kinds of bound states and their properties that can occur in quantum field theory are studied. The ability of quantum field theory to create and destroy particles makes the picture of a bound state very complex. However, for this very reason it allows for a larger variety of bound states than can occur in nonrelativistic quantum mechanics. Not only are those bound states that appear as poles in the tau functions considered but also as branch points. The bound states that appear as branch points offer many new possibilities in constructing composite theories. An example of this type of bound state is given in which the fermion is a bound state of a boson. The many ambiguities that exist with this kind of bound state are illustrated. In discussing the bound states that appear as poles they are broken into three subgroups: N-body bound states, mixed bound states, and self-interacting bound states. The N-body bound states are the most analogous to those occurring in nonrelativistic quantum mechanics. The mixed bound states have the peculiar property of not being composed of any unique group of elementary particles. The self-interacting bound states are those that are directly coupled with themselves. The characteristics of these subgroups of bound states are discussed and illustrated. (auth)

27852 ASYMPTOTIC FIELDS IN SOME MODELS OF QUANTUM FIELD THEORY. II. Hoegh-Krohn, Raphael (Univ., Oslo). J. Math. Phys. (N. Y.), 10: 639-43(Apr. 1969).

A quantum field with nonlocal but translation-invariant interaction is considered. It is proven that, with a proper smoothness condition on the interaction, the asymptotic limits of the annihilation–creation operators exist. The asymptotic limits are then used to prove that the state space decomposes as a tensor product of an incoming (outgoing) Fock space and a zero-particle space. (auth)

27853 POWERS OF THE D FUNCTIONS. Gomatam, Jagannathan; Rohrlich, F. (Syracuse Univ., N. Y.). J. Math. Phys. (N. Y.), 10: 614-16(Apr. 1969).

While powers of distributions in general do not exist, $[D_+]^n$ and $[D_-]^n$ are the exceptions among all D functions; they do exist and are given explicitly. A "modified" power $[D_\Gamma]_n$ based on the representation of D_Γ as analytic functionals can be defined. It exists for all homogeneous D_Γ, i.e., for $D_\pm$, D, and D_1. The relation of $[D_\pm]_n$ to $[D_\pm]^n$ is given, and explicit expressions are found in x space and p space. The Källén–Lehmann–Umezawa–Kamefuchi representation of these distributions is derived. The extent to which these considerations are applicable to the $\Delta_\Gamma(x,m)$, $m > 0$, is discussed. (auth)

27854 AN INTRODUCTION TO FIELD QUANTIZATION. Takahashi, Y. International Series of Monographs in Natural Philosophy. Volume 20. Oxford, Pergamon Press, 1969. 308p. $10.00.

The discussion of field quantization covers nonrelativistic fields, relativistic free fields, linear field equations, quantization of relativistic free fields, and the transformation properties of field operators. Also discussed are an explicit construction of wave functions, and interacting fields. (J.F.P.)

27855 EXAMPLE OF TIME DILATION AND LENGTH CONTRACTION IN THE SPECIAL THEORY OF RELATIVITY. Feng, Shih-yu (Chung Chi Coll., Hong Kong). Chin. J. Phys. (Taiwan), 6: 116-18(Oct. 1968).

An example is given to show the concepts of time dilation and of length contraction in the special theory of relativity. (auth)

27856 COVARIANT QUANTIZATION OF FIELDS. Polcyn, Roger F. Coral Gables, Fla., Univ. of Miami, 1968. 52p. Thesis.

A method of covariant quantization of fields satisfying the most general first order relativistic wave equation is developed. The method applies to fields of integral and half-integral spin. The consistency of free field quantization and the number and type of constraints which may be necessary are determined by the structure of the characteristic matrix operator. The connection between spin and statistics is also given in terms of this operator. (Disser. Abstr.)

27857 COVARIANT GENERALIZATION OF THE SPIN OPERATOR AS A CONCLUSION FROM THE DIRAC EQUATION. Hanus, Wanda (Univ., Amsterdam). Nucl. Phys., B10: 339-48 (1969).

The known covariant description of the spin of the Dirac particle (in terms of the Bargmann–Wigner four-vector and of the conserved spin tensor) was deduced by a pure quantum-mechanical method starting from a special, manifestly covariant, Hamiltonian form of the Dirac equation. Some simple arguments of the space-time geometry were used in this deduction. The obtained result shows that the covariant generalization of the spin operator may be treated as a consequence of the Dirac equation, in spite of a rather passive role played by it in achieving this generalization. (auth)

27858 THE MUON ENERGY SPECTRUM AS A TEST OF THE VALIDITY OF SPECIAL RELATIVITY AT SMALL DISTANCES. Dardo, M.; Navarra, G.; Penengo, P. (Univ., Turin). Nuovo Cim., 61A: 219-24(May 21, 1969).

The recent observation of Lundberg and Rédei that a violation of the principles of special relativity at small distances would cause a change in the lifetime of pions and muons is submitted to a test against cosmic-ray data. It is shown that at sufficiently high energies the muon energy spectrum and the zenith angle distribution of muons will be affected by the assumed violation. Present experimental data permit us to establish an upper limit to $5 \cdot 10^{-17}$ cm for the dimensions in which special relativity may not be valid. (auth)

27859 ON THE SPECTRUM OF INTERNAL SYMMETRIES IN THE ALGEBRAIC QUANTUM FIELD THEORY. Jadczyk, A. Z. (Univ. of Wroclaw). Commun. Math. Phys., 12: 58-63 (1969).

It is shown that the point spectrum of internal symmetries is always symmetric. It is a group provided the intersection of all local subalgebras is trivial. (auth)

27860 SYMMETRIES INDUCED BY CONSERVED VECTOR CURRENTS IN THE THEORY OF A SCALAR FIELD. Lopuszanski, Jan T. (Univ. of Wroclaw. Inst. of Low Temperature Physics and Structural Research, Wroclaw). Commun. Math. Phys., 12: 80-90(1969).

A quantum theory of one scalar, real, local, Poincaré covariant field A(x) with the restricted spectrum condition (massive one particle states and a unique vacuum) is considered. The asymptotic fields $A_{(in/out)}(x)$ are assumed to be irreducible. The conjecture is that under some technical assumptions the "charge" of every real, hermitean, locally conserved, Poincaré covariant quantum (pseudo) vector field $j_\mu(x)$ relatively local to A(x), appearing in this theory vanishes. This means that in a theory of one scalar, real field with a massive particle one can not expect to get symmetry groups induced by conserved (pseudo) vector currents, only by global, selfadjoint, Poincaré invariant generators. The arguments can be easily extended to a theory of one complex scalar field, in this case the only symmetry transformation induced by a current can be the gauge transformation. It is proven also that under very weak assumptions two fields related to each other by a unitary (or similarity) transformation are equal barring some pathological cases. (auth)

27861 QUANTUM LOGIC APPROACH TO QUANTUM MECHANICS. Gudder, S. (Univ. of Wisconsin, Madison). Commun. Math. Phys., 12: 1-15(1969).

A quantum logic structure for quantum mechanics which contains the concepts of a physical space, localizability, and symmetry groups is formulated. It is shown that there is an underlying Hilbert space which mirrors much of this axiomatic structure. Quantum fields are defined and shown to arise naturally from the quantum logic structure. The fields of Haag and Wightman are generalized to this theory and an attempt is made to find a local equivalence for these fields. (auth)

Gravitation and General Relativity

27862 (DESY-69/11) EQUAL-TIME COMMUTATORS AND THE ENERGY-MOMENTUM TENSOR. Genz, H.; Katz, J. (Hamburg Univ. (West Germany). Institut fuer Theoretische Physics (II)). Mar. 1969. 21p. Dep.

Starting from a generalization to spinor fields $\bar{\psi}$ of the equal-time commutator between the time components of the vector and axial vector currents V_0^i and A_0^i and the energy density part of the gravitational tensor current-field commutators are investigated. Assuming that the equal-time commutators $[V_0^i(\vec{x},x_0), \bar{\psi}(\vec{y}, x_0)]$ and $[A_0^i(\vec{x},x_0), \bar{\psi}(\vec{y},x_0)]$ are proportional to the field itself and have no Schwinger terms the absence of Schwinger terms in the equal-time commutator $[V_k^i(\vec{x},x_0), \bar{\psi}(\vec{y},x_0)]$, $[A_k^i(\vec{x},x_0), \bar{\psi}(\vec{y},x_0)]$, and $[(\partial/\partial x_\mu) A_\mu^i(\vec{x},x_0), \bar{\psi}(\vec{y},x_0)]$ is shown. Thus $[(\partial/\partial x_0) V_0^i(\vec{x},x_0), \bar{\psi}(\vec{y},x_0)]$ only contains a first order Schwinger term and $[(\partial/\partial x_0) A_0^i(\vec{x},x_0), \bar{\psi}(\vec{y},x_0)]$ only contains a non-Schwinger term and a first order Schwinger term. In addition it is shown that quark model results for $[V_\mu^i(\vec{x},x_0), \bar{\psi}(\vec{y},x_0)]$ and $[A_\mu^i(\vec{x},x_0), \bar{\psi}(\vec{y},x_0)]$ follow from assuming the transformation properties of these equal-time commutators to be identical to those of $\bar{\psi}\gamma_\mu\gamma_4$. The possible deviations from the quark model are shown to be given by the equal-time commutators between the spinor current $f_m(x)$ and the vector and axial vector currents. Some implications for quark model and algebra of fields current commutators are discussed. Finally symmetry breaking is considered. It is shown that if the non-Schwinger part of the equal-time commutator between the time components of conserved currents is the time component of a current, then this current is conserved. Necessary and sufficient conditions are given in order for the non-Schwinger part of the equal-time commutators between the time components of conserved and nonconserved currents or between the time components of nonconserved currents to be the time component of a conserved or nonconserved current. (auth)

27863 GROUP-THEORETIC APPROACH TO THE NEW CONSERVED QUANTITIES IN GENERAL RELATIVITY. Carmeli, Moshe (Aerospace Research Labs., Wright-Patterson AFB, Ohio). J. Math. Phys. (N. Y.), 10: 569-74(Apr. 1969).

The Newman–Penrose formalism for obtaining the recent conserved quantities in general relativity is discussed and a group-theoretic interpretation is given to it. This is done by relating each triad of the orthonormal vectors on the sphere to an orthogonal matrix g. As a result, the spin-weighted quantities η become functions on the group of three-dimensional rotation, $\eta = \eta(g)$, where $g \in O_3$. An explicit form for the matrix g is given and a prescription for rewriting $\eta(g)$ as functions of the spherical coordinates is also given. It is shown that a quantity of spin weight s can be expanded as a series in the matrix elements T^j_{sm} of the irreducible representation of O_3, where s is fixed. Infinite- and finite-dimensional representations of the group SU_2 are then realized in the spaces of η's and T^j_{sm}. It is shown that the infinite-dimensional representation is not irreducible; its decomposition into irreducible parts leads to the expansion of η in the T^j_{sm}, the latter providing invariant subspaces in which irreducible representations act. (auth)

27864 CURVATURE COLLINEATIONS: A FUNDAMENTAL SYMMETRY PROPERTY OF THE SPACE–TIMES OF GENERAL RELATIVITY DEFINED BY THE VANISHING LIE DERIVATIVE

OF THE RIEMANN CURVATURE TENSOR. **Katzin, Gerald H.; Levine, Jack; Davis, William R. (North Carolina State Univ., Raleigh). J. Math. Phys. (N. Y.), 10: 617-29(Apr. 1969).**

A Riemannian space V_n is said to admit a particular symmetry which is called a "curvature collineation" (CC) if there exists a vector ξ^i for which $\pounds_\xi R^i_{jkm} = 0$, where R^i_{jkm} is the Riemann curvature tensor and $\pounds_\xi$ denotes the Lie derivative. The investigation of this symmetry property of space–time is strongly motivated by the all-important role of the Riemannian curvature tensor in the theory of general relativity. For space–times with zero Ricci tensor, it follows that the more familiar symmetries such as projective and conformal collineations (including affine collineations, motions, conformal and homothetic motions) are subcases of CC. In a V_4 with vanishing scalar curvature R, a covariant conservation law generator is obtained as a consequence of the existence of a CC. This generator is shown to be directly related to a generator obtained by means of a direct construction by Sachs for null electromagnetic radiation fields. For pure null-gravitational space–times (implying vanishing Ricci tensor) which admit CC a similar covariant conservation law generator is shown to exist. In addition it is found that such space–times admit the more general generator (recently mentioned by Komar for the case of Killing vectors) of the form $(\sqrt{-g}\, T^{ijkm}\xi_i\xi_j\xi_k)_{;m} = 0$, involving the Bel–Robinson tensor T^{ijkm}. Also it is found that the identity of Komar, $[\sqrt{-g}(\xi^{i;j} - \xi^{j;i})]_{;i;j} = 0$, which serves as a covariant generator of field conservation laws in the theory of general relativity appears in a natural manner as an essentially trivial necessary condition for the existence of a CC in space–time. In addition it is shown that for a particular class of CC $\pounds_\xi K$ is proportional to K, where K is the Riemannian curvature defined at a point in terms of two vectors, one of which is the CC vector. It is also shown that a space–time which admits certain types of CC also admits cubic first integrals for mass particles with geodesic trajectories. Finally, a class of null electromagnetic space–times is analyzed in detail to obtain the explicit CC vectors which they admit. (auth)

27865 MASSIVE VECTOR MESON INTERACTING WITH THE GRAVITATIONAL FIELD. I. GENERAL FORMALISM. **Tauber, G. E. (Tel-Aviv Univ., Israel). J. Math. Phys. (N. Y.), 10: 633-8(Apr. 1969).**

Starting from the covariant field equations for a vector meson, the energy–momentum tensor entering in Einstein's field equations is derived. It is shown that its most general algebraic form involves two vector fields and two scalars. Specifying the formalism to the special cases for which the fields are either parallel or perpendicular to each other, it is found that the vector field cannot be described in terms of a perfect fluid involving only density and pressure, but includes an additional term involving the stresses. The conservation laws are given, which, in addition to the ones of relativistic hydrodynamics, also include the ones describing the streaming of the vector field. (auth)

27866 FIRST-ORDER APPROXIMATION TO A SPHERICALLY SYMMETRIC SOLUTION OF EINSTEIN'S EQUATIONS. **Stabell, R. (Univ. of Illinois, Urbana). J. Math. Phys. (N. Y.), 10: 735-9(Apr. 1969).**

In analogy with the metrics of Schwarzschild and de Sitter, a first-order approximation to the spherically symmetric solution of Einstein's field equations is found where the deviation from the flat Minkowski space–time is given by potentials of the gravitational force and the cosmical Λ force. It is shown that in the Newtonian approximation the forces acting per unit mass of the fluid are the assumed gravitational self-attraction and cosmical Λ force. (auth)

27867 ON A SINGULARITY OF THE SPHERICALLY SYMMETRICAL SOLUTION OF EINSTEIN'S EQUATIONS. Korkina, M. P. (Dnepropetrovsk State Univ., USSR). Ukr. Fiz. Zh., 14: 38-42(Jan. 1969). (In Russian).

It is shown that the singularity of Schwarzschild's solution on the gravitational radius is removed in all the systems of coordinates where metrical coefficients are functions of the sum (z + t). The Lemaitre metric is obtained from the considered systems as a particular case. The reasons of the appearance of the singularity and of the possibility of its removal in a general case are considered. (auth)

27868 REVISED THEORY OF GENERAL RELATIVITY AND QUANTIZATION OF THE GRAVITATIONAL FIELD. II. **Rayski, J. (Jagellonian Univ., Krakow). Acta Phys. Pol., 35: 523-8(Apr. 1969).**

By modifying the Lagrangian and introducing some coordinate conditions the theory of gravitation can be modified (without spoiling its most beautiful feature: the connection between gravitation and geometry). In contradistinction to the traditional theory there exist solutions representing truly localized wave packets, energy-momentum is localized, and a linear approximation is meaningful. The modified theory is quantizable. (auth)

27869 STATICAL GRAVITATIONAL FIELDS IN SECOND APPROXIMATION. **Synge, J. L. (Dublin Inst. for Advanced Studies). Proc. Roy. Irish Acad., Sect. A, 67: No. 5, 47-66 (Mar. 31, 1969).**

A new method is given for calculating the gravitational field of a single massive body at rest. The method involves successive approximations based on the relaxation of Einstein's field equations, and is carried out to include the second approximation. This means that terms of order m^2 are retained as significant, and there is an error of order m^3 in the field equations, m being the mass of the body. (auth)

27870 AXIALLY SYMMETRIC LINE ELEMENT AND RELATIVE MASS IN GENERAL RELATIVITY. **Sharma, N. K. (Univ. of Rajasthan, Jaipur, India). Curr. Sci. (India), 38: 236-7(May 20, 1969).**

The field equation $\nabla^2\gamma_{\mu\nu} = 0$ and the coordinate conditions $\gamma_{\mu s,s}$ are used as the basis of the derivation of a linearized first-order axially symmetric line element outside a mass point. It is also of interest to find an equivalent line-element in curvature coordinates and then to compare this with the linearized form of the Kerr metric. (J.F.P.)

27871 IMMERSIONS OF SPACE–TIME. **Rastall, Peter (Univ. of British Columbia, Vancouver). Can. J. Phys., 47: 607-9(Mar. 15, 1969).**

It is shown that space-time can be regarded as a 4-dimensional subspace of a conformally flat, 6-dimensional space, or of a flat, 8-dimensional space. The group of isometries of the tangent space of the 6-dimensional space is O(4,2), which has recently been used to describe elementary particles. (auth)

27872 CONSTRUCTION OF APPROXIMATE RADIATIVE SOLUTIONS TO THE EINSTEIN EQUATIONS. **Choquet-Bruhat, Y. (Institut Poincare, Paris). Commun. Math. Phys., 12: 16-35(1969). (In French).**

An hyperbolic metric $g_{\alpha\beta}(x,\omega\varphi) = g^0_{\alpha\beta}(x) + 1/\omega\ g^1_{\alpha\beta}(x,\omega\varphi) + 1/\omega^2\ g^2_{\alpha\beta}(x,\omega\varphi)$ (1) where x is a point of the space-time V_4, φ a scalar function on V_4 (the "phase") and ω a great parameter (the "frequency") is constructed rigorously without any averaging scheme. This metric is an approximate solution of Einstein's equations: it verifies $R_{\alpha\beta} = 0(\omega^{-1})$, (2) $g^0_{\alpha\beta}$ and its derivatives, $g^1_{\alpha\beta}$ and $g^2_{\alpha\beta}$ being bounded, the first and second derivatives of $g^1_{\alpha\beta}$, $g^2_{\alpha\beta}$ of order respectively $0(\omega)$ and $0(\omega^2)$. It is shown first that the Ricci tensor of (1) stays bounded (when ω increases), with a perturbation $g^1_{\alpha\beta}$ physically significant, if and only if φ verifies the characteristic equation of the back-ground metric and $g^1_{\alpha\beta}$ four algebraic, linear relations, (5.7) and (5.8) in radiative coordinates $x^0 = \varphi$. It is shown afterwards that (1) satisfies (2) if $g^1_{\alpha\beta}$ satisfies ordinary diffrential first order equations (which take a very simple form in radiative coordinates) along the rays of the background, the preceding algebraic relations can be considered as "initial conditions" if the Ricci tensor of the background is of the radiative form $R_{\alpha\beta}(g^0_{\lambda\mu}) = \tau\partial_\alpha\varphi\partial_\beta\varphi$. (3) It is possible to find $g^1_{\alpha\beta}$ and $g^2_{\alpha\beta}$ with the required conditions of boundedness only if $\tau > 0$. The results are applied to the Vaydya metric and it is shown that, by an oscillatory perturbation of this metric one can satisfy Einstein's equations (to the order ω^{-1}) if the coefficient m usually interpreted as the mass is a decreasing function of $\varphi = u$, which gives, in this context, a proof of the loss of mass by gravitational radiation. (auth)

27873 ELECTROMAGNETIC CAVITY RESONANCES IN ACCELERATED SYSTEMS. II. **Yildiz, Asim (Univ. of New Hampshire, Durham). Nuovo Cim., 61B: 1-11(May 11, 1969).**

Electromagnetic-cavity resonances in a rotationally induced gravitational field are investigated using the gravitational tensor $g_{\alpha\beta}$ as the structural element in Maxwell's equations. The constitutive relations are expressed by tensorial relation in free space by $\mathfrak{F}^{hi} = \sqrt{\epsilon_0/\mu_0}\, g^{\frac{1}{2}} g^{hj} g^{ik} F_{jk}$. The equations have the four-dimensional invariant form if F_{jk} is considered as a covariant bivector in 4-dimensional space which admits all orthogonal homogeneous transformations (rotations and reflections). G4 is a subgroup of the general affine or Poincaré group. The method presented here is the metric approach generalized so as to accommodate all possible experimental data. This is achieved by simply decomposing the gravitational tensor into vacuum and material parts and performing proper transformations of the decomposed parts separately or simultaneously in accordance with the experimental configuration under consideration. Furthermore the comparison of this presentation with that of the nonmetric approach is discussed. (auth)

27874 GRAVITATIONAL EFFECT OF ELECTROMAGNETIC RADIATION. **Hegarty, J. C. (Boston Univ.). Nuovo Cim., 61B: 47-52(May 11, 1969).**

The effect of the gravitational field, produced by a pulse of electromagnetic radiation, on a test particle is evaluated by using the linearized form of the Einstein field equations. It is found that the impulse transmitted to the test particle in the direction of propagation is equal in magnitude and opposite in direction to the momentum change of the photon which occurs in the gravitational red-shift. (auth)

27875 EQUATIONS OF MOTION OF A PARTICLE WITH SPIN AND ADDITIONAL CONDITIONS. **Micoulaut, R. (Centre d,Etudes de Limeil, Villeneuve-Saint-Georges, France). Nuovo Cim., 61B: 141-8(May 11, 1969). (In French).**

It is proposed in bringing in the field of an arbitrary observer, to attempt the generalizing of the further conditions to add to the equations of motion of a spin particle in order to fully determine the motion. (auth)

Scattering Theory

Refer also to abstracts 27795 and 27832.

27876 S-MATRIX SINGULARITY STRUCTURE IN THE PHYSICAL REGION. II. UNITARITY INTEGRALS. **Bloxham, M. J. W.; Olive, D. I.; Polkinghorne, J. C. (Cambridge Univ., Eng.). J. Math. Phys. (N. Y.), 10: 545-52(Apr. 1969).**

The general techniques developed earlier are applied to evaluate the singularities and discontinuities of unitarity integrals. The results are conveniently expressed in terms of what is called mechanism (or M) diagrams. (auth)

27877 S-MATRIX SINGULARITY STRUCTURE IN THE PHYSICAL REGION. III. GENERAL DISCUSSION OF SIMPLE LANDAU SINGULARITIES. **Bloxham, M. J. W.; Olive, D. I.; Polkinghorne, J. C. (Cambridge Univ., Eng.). J. Math. Phys. (N. Y.), 10: 553-61(Apr. 1969).**

Drawing on the understanding of unitarity integrals acquired previously, it is shown that unitarity demands that connected amplitudes be singular on the positive α arcs of all "simple" Landau curves in their physical regions. Further, it is shown that the amplitudes are nonsingular on mixed α arcs, while on the positive α arcs their discontinuities are given by the Cutkosky rule. This confirms arguments from perturbation theory and demonstrates how a weak analyticity assumption can generate in an exact way a singularity scheme relating to causality. (auth)

27878 HIGH-ENERGY SCATTERING CROSS SECTION FOR SINGULAR POTENTIALS AT LARGE ANGLES. **Spector, Richard M. (Wayne State Univ., Detroit). J. Math. Phys. (N. Y.), 10: 503-5(Mar. 1969).**

For scattering off singular repulsive potentials at high energy, the large-angle scattering is shown to be classical. For nonrelativistic singular potentials of the form $V(r) = gr^{-n} (g > 0, n > 2)$, the explicit form of the differential cross section is given for large angles at high energy as a power series in $(\pi - \theta)$. The coefficients of the linear through cubic terms in $(\pi - \theta)$ are obtained. (auth)

27879 PHYSICAL-REGION DISCONTINUITY EQUATIONS FOR MANY-PARTICLE SCATTERING AMPLITUDES. I. **Coster, Joseph; Stapp, Henry P. (Univ. of California, Berkeley). J. Math. Phys. (N. Y.), 10: 371-96(Mar. 1969).**

The discontinuity equations are derived for all singularities of multiparticle scattering functions that enter the portion of the physical region lying below the four-particle threshold. These equations, which are the precise statements of the Cutkosky formulas, are calculated directly from the unitarity equations. The only analyticity properties used are those obtained from the S-matrix macroscopic-causality condition. That is, the scattering functions are taken to be analytic in the physical region except on positive-α Landau surfaces, around which they continue in accordance with the well-defined plus-$i\epsilon$ rule. (auth)

27880 S-MATRIX SINGULARITY STRUCTURE IN THE PHYSICAL REGION. I. PROPERTIES OF MULTIPLE INTEGRALS. **Bloxham, M. J. W.; Olive, D. I.; Polkinghorne, J. C. (Cambridge Univ., Eng.). J. Math. Phys. (N. Y.), 10: 494-502 (Mar. 1969).**

The real singularities and corresponding discontinuities of a class of multiple integrals over real contours are obtained. The aim is to give a unified treatment, obtaining, by elementary mathematical methods, both previously known results and some new generalizations. (auth)

27881 SOME ANALYTIC PROPERTIES OF SCATTERING AMPLITUDES FOR LONG-RANGE FORCES. **Ross, William R.; Taylor, John R. (Univ. of Colorado, Boulder). J. Math. Phys. (N. Y.), 10: 654-60(Apr. 1969).**

The properties of the partial-wave amplitude $a(l,k)$ and the full amplitude $A(k, \cos\theta)$ for scattering by a long-range potential made up of a Coulomb part $2\alpha/r$ and a short-range part $V(r)$ are examined. The properties of $a(l,k)$ as an analytic function of l and k are shown to be quite similar to those of the usual short-range amplitude, except in the neighborhood of the threshold $k = 0$, which point is examined in detail. The full amplitude is treated as a function of $\cos\theta$ for fixed physical momentum k; using the Sommerfeld–Watson transformation, it is shown that $A(k, \cos\theta)$ is analytic in the cut plane of $\cos\theta$. (auth)

27882 PROBLEMS OF DRESSING OF THE OPERATORS AND UNITARITY OF RENORMALIZED S MATRIX IN AXIOMATIC FIELD THEORY. **Sukhanov, A. D. (Moscow Mining Inst.). Yadern. Fiz., 9: 653-64(Mar. 1969). (In Russian).**

In the framework of the axiomatic approach the question is considered about "dressing" various variables under the action of model S matrix (S_R) that corresponds to the counter term of the field renormalization in the Lagrangian approach. In so doing the charge is unchanged and the functional argument varies: the free field $\varphi(x)$ is substituted by the "dressed" field $A_R(x)$ that belongs to a nonequivalent representation of the commutation relations. The S matrix, the Heisenberg operators and various nonlinear relations are "dressed." It is shown that introducing the S_R matrix only with the nonrenormalized primary matrix S_0 unchanged, the unitarity of the theory is violated. In other words the renormalization implies simultaneous changes of the S_0 matrix, in particular a formal transformation of the normal products of the $\varphi(x)$ fields into products of some other kind. (auth)

27883 ON REGGE POLES IN SCATTERING IN THE COULOMB FIELD. **Liberman, M. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 9: 665-9(Mar. 1969). (In Russian).**

The Regge poles for the scattering in the Coulomb field are considered. It is shown that the Regge-pole "daughter trajectories" result from the fact that the Coulomb problem has the dynamical symmetry group. (auth)

27884 OSCILLATIONS OF THE SCATTERING AMPLITUDE AND RESTRICTIONS ON ITS HIGH-ENERGY BEHAVIOR. **Lomsadze, Yu. M.; Kontrosh, E. Z.; Tokar, S. S. (Uzhgorod State Univ., USSR). Ukr. Fiz. Zh., 14: 30-7(Jan. 1969). (In Russian).**

A modified Meyman Theorem I is proved. By means of it the upper Froissart–Martin bound for the scattering amplitude $f(s) \equiv f(s,t = 0)$ is lowered in various assumptions concerning the behavior of $H(s) \equiv \text{Im}\, f(s)/\text{Re}\, f(s)$ for the physical $s \to \infty$ provided the pathologically strong oscillations of $f(s)$ in a strictly formulated sense are absent, for this one makes use of the analyticity of the amplitude only in the upper s-half-plane. When proving, one takes into account that the amplitude $f(s)$ for the real s is a generalized but not an ordinary function. This result strengthens those obtained recently by Khuri, Kinoshita and Vernov. It is extended to the case of the arbitrary binary reaction. The advantages of introducing the Meyman asymptotical amplitudes are pointed out. (auth)

27885 HIGH-ENERGY BEHAVIOR OF THE BARDAKCI-RUEGG AMPLITUDE. **Bialas, A.; Pokorski, S. (CERN, Geneva). Nucl. Phys., B10: 399-409(1969).**

The behavior of the five-point function proposed by Bardakci and Ruegg is discussed in the kinematical region of high-energy and small momentum transfers. Both single and double Regge limits are given explicitly in terms of the hypergeometric functions. When applied to the single-particle production at high energy, the formulas suggest a Regge exchange model in which the structure of the vertices is explicitly given. (auth)

27886 CROSSING SYMMETRIC, REGGE-BEHAVED AMPLITUDE FOR A GENERAL TRAJECTORY. **Boguta, J. (Univ., Bonn). Nucl. Phys., B10: 319-22(1969).**

For any polynomially bounded Regge trajectory α, an amplitude is constructed which is crossing-symmetric, Regge-behaved, has resonance poles to which only a finite number of partial waves contribute and is polynomially bounded. The amplitude is analytic in its variables with the usual unitarity cuts. The example is based on the generalized interference model of Kupsch. (auth)

27887 ON THE ZERO POINTS OF THE MANDELSTAM DENOMINATORS IN THE COMPLEX s-PLANE: THE GENERAL TWO-BODY PROCESS. **Blazek, M. (Inst. of Physics, Bratislava). Czech. J. Phys., 19: 589-633(1969).**

The relativistic two-body into two-body processes are considered. The areas are described where the denominators of the Mandelstam representation vanish in the complex s-plane if the momentum transfer squared t and the scattering angle ϑ in the direct channel have physical values. The equations of the lines are given along which either cos ϑ = const and t varies or t = const and cos ϑ varies. The cuts along later lines are suggested if the continua in the crossed channels are replaced by particles. In the general mass case, it is shown that the location of the branch points in the integrand of the partial wave amplitude in the complex s-plane depends on the integration involved. However, any elastic process represents a degeneration when the mentioned dependence does not appear. (auth)

27888 A REMARK ON THE TOLLER ω DEPENDENCE OF TWO-REGGEON–ONE-PARTICLE VERTEX FUNCTIONS. Morrow, R. A. (Dartmouth Coll., Hanover, N. H.). Nuovo Cim., 61A: 215-18(May 21, 1969).

It is pointed out that a two-Reggeon–one-particle vertex function in a multi-Regge amplitude is independent of the associated Toller angle ω if the trajectory of one of the Reggeons is zero. (auth)

27889 LEAST-SQUARES CALCULATION OF SCATTERING WITH THE BETHE–SALPETER EQUATION. Ladanyi, K. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Nuovo Cim., 61A: 173-87(May 21, 1969).

A least-squares method of calculating phase shifts from the Bethe–Salpeter differential equation is presented. In order to avoid some difficulties in evaluating the stationary expression, the exact asymptotic form of the partial waves is approximated by an expansion involving the four-dimensional spherical harmonics. The boundary conditions on the wave function can be imposed in a simple way. The numerical calculations were done for s-wave phase shifts at several energies including the three-particle inelastic region. (auth)

27890 EXTENSIONS OF AN APPROACH TO CURRENTS: THREE- AND FOUR-POINT FUNCTIONS OF CURRENTS. Lu, E. Y. C. (Ohio State Univ., Columbus). Nuovo Cim., 61A: 249-62(May 21, 1969).

Previous work on the construction of an S-matrix theory of currents on the basis of unitarity, analyticity, Lorentz invariance and crossing is extended. The integral representations of third- and fourth-order current elements in terms of first-order current operators are obtained assuming that the current elements satisfy an unsubtracted Mandelstam representation. Corresponding representations are then obtained for S-matrix elements which are similar to that of the LSZ reduction formulas. (auth)

27891 COVARIANT SPIN OPERATORS AND THE KINEMATICS OF HELICITY AMPLITUDES. King, M. J. (Johns Hopkins Univ., Baltimore). Nuovo Cim., 61A: 273-88(May 21, 1969).

The kinematical singularities and constraints of helicity amplitudes at thresholds and pseudothresholds are investigated within the formalism of covariant spin operators. Constraint equations for the amplitudes are derived for two-body scattering processes of the following three types: (a) different thresholds and pseudothresholds in the initial and final states, (b) elastic scattering, and (c) particles of equal mass in both the initial and final states. It is shown that, under certain conditions, the derivatives of the helicity amplitudes satisfy similar equations. The method of investigation is essentially equivalent to using crossing, but arises in a natural way through the use of transformations between different covariant spin operators, without reference to the crossed channel. (auth)

27892 COMMENTS ON REGGE POLES AND RESONANCE CIRCLES. Schmid, C. (CERN, Geneva). Nuovo Cim., 61A: 289-302(May 21, 1969).

Various objections raised against the resonance interpretation of the Argand-diagram loops which are generated by Regge-pole exchanges are discussed. (auth)

27893 ANOMALOUS SINGULARITIES IN FADDEEV AND REDUCED RELATIVISTIC FINAL-STATE EQUATIONS. Riordan, F. (Yale Univ., New Haven). Nuovo Cim., 61A: 303-6 (May 21, 1969).

Relativistic Faddeev equations with one particle in the two-particle integrations off mass shell are shown to extract certain anomalous singularities. The kernel of the two- "particle" equations with the quasi-particle off mass shell to which these Faddeev equations reduce can be simply approximated because of this result. (auth)

27894 RELATIVISTIC QUASIPOTENTIAL MODEL OF PARTICLE SCATTERING AT HIGH ENERGIES. Garsevanishvili, V. R.; Matveev, V. A.; Slepchenko, L. A.; Tavkhelidze, A. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Lett., 29B: 191-2(Apr. 28, 1969).

A relativistic model of high-energy elastic scattering is considered on the basis of the quasipotential equation in quantum field theory. The behavior of the scattering amplitude for small and large momentum transfers is investigated. (auth)

27895 WHY DO TRAJECTORIES RISE? Tiktopoulos, G. (Univ. of Helsinki). Phys. Lett., 29B: 185-7(Apr. 28, 1969).

Infinite sequences of narrow-width Regge recurrences are shown to arise in scattering amplitudes derived from energy-dependent local potentials, according to two distinct mechanisms. (auth)

Particle Accelerators

Refer also to abstracts 27038, 28232, 28243, and 28261.

27896 (AD–680020) NRL VAN DE GRAAFF OPERATION, JANUARY 1–JUNE 30, 1968. (Naval Research Lab., Washington, D. C.). July 1968. 21p. (NRL-MR–1930). CFSTI.

This report is the first of a series of semiannual summaries on the operation and use of the NRL 5-MV Van de Graaff accelerator and associated instruments. Brief accounts of the research and development projects under way are included. (auth) (USGRDR)

27897 (AWRE-O–1/69) ELECTRICAL BREAKDOWN BETWEEN ERBIUM OXIDE, ERBIUM DEUTERIDE, AND MOLYBDENUM ELECTRODES IN A VACUUM. Owen, W. D.; Davies, M. H.; Powell, W. D. (Atomic Weapons Research Establishment, Aldermaston (England)). Feb. 1969. 32p. Dep. CFSTI. UK 4s. 6d.

The results are given of investigations of spark breakdown conditioning, gap dependence of pre-breakdown and breakdown parameters, and reverse polarity sparking carried out using erbium oxide and erbium deuteride cathodes with molybdenum anodes at residual pressures of $<10^{-9}$ torr. (UK)

27898 (BNL–13479) THE 30 MeV THREE-STAGE VAN DE GRAAFF FACILITY AND ITS ASSOCIATED RESEARCH PROGRAM AT BROOKHAVEN NATIONAL LABORATORY. Wegner, H. E. (Brookhaven National Lab., Upton, N. Y.). [1969]. 19p. (CONF-690115–1). Dep. CFSTI.

From 19th Conference on Nuclear Spectroscopy and Structure of the Atomic Nucleus, Yerevan, USSR.

Design and development of the 30-MeV three-stage Van de Graaff accelerator and experimental facilities are discussed. The flexibility in the arrangement of accelerators and design of the building structure allow the accelerators to be used in two different acceleration modes and to accelerate unusual particles like tritium and helium-6. (W.H.K.)

27899 (BNL–13567) DATA ACQUISITION AND ANALYSIS COMPLEX FOR THE BNL LOW ENERGY ACCELERATOR FACILITY. Rogers, P. C. (Brookhaven National Lab., Upton, N. Y.). [1969]. 11p. (CONF-690301–5). Dep. CFSTI.

From Conference on Computer Systems in Experimental Nuclear Physics, Skytop, Pa.

The Data Acquisition and Analysis Complex is based on an SDS Sigma-7 computer with special purpose hardware. This complex will be time-shared by users at four independent accelerators. Each user may perform computations or data analysis while simultaneously collecting data and displaying results. A special feature of this complex is that the displays, programs, and data are maintained on disc memories thus freeing the central processor and core memory for independent time-sharing tasks. (auth)

27900 (CEA-R–3729) STUDY OF AXIAL INJECTION OF POLARIZED PROTONS INTO THE GRENOBLE CYCLOTRON. Pabot, Jean-Louis (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). 1969. 103p. (In French). Dep.

Thesis. Submitted to Univ., Grenoble, France.

By injecting ions axially into a cyclotron, it is possible to accelerate particles (polarized particles, heavy ions, etc . . .) obtainable only with difficulty when an internal ion source is used. After justifying the choice of an axial injection device equippped with a "pseudo-cylindrical" deflector for the Grenoble cyclotron, the principle of such a deflector, the choice of its parameters, and the effect of this choice on the conditions of acceleration of the beam by the cyclotron are studied. Two operations are described which made it possible to check that the chosen injection device operated satisfactorily, qualitatively initially (electron model), then quantitatively (proton model). In conclusion, it is believed that the Grenoble cyclotron thus equipped will be able to provide a relatively dense beam of polarized protons. (auth)

27901 (CERN–69-3) GENERAL PROPERTIES OF FIELDS AND BEAM DYNAMICS IN A LINAC GAP. Schnizer, B. (European Organization for Nuclear Research, Geneva (Switzerland)). Mar. 12, 1969. 146p. Dep.

An extensive and detailed derivation of non-relativistic and relativistic difference equations describing the motion of a single proton through an Alvarez structure linac gap is given extending the difference equations given by P. Lapostolle at the Frascati Conference (1965). Integral representations of the field in such a gap are derived and their properties are discussed as well as those of the field amplitude which is proportional to the transit time factor. Beam dynamics coefficients are defined which are Fourier transforms of the fields. There are two types of them: T-coefficients which are known as soon as the transit time factor is given and which occur in difference equations describing the change of particle coordinates across the whole gap. In difference equations across the first half of it enter in addition the S-coefficients which are much more complicated. Beam dynamics equations are derived by first order perturbation theory regarding as perturbation the influence of the radio frequency field (with angular frequency ω) on free particle motion. This is equivalent to solving the equations of motion by iteration starting from free particle motion, but the present method is more definite. The magnitude of the perturbation is described by the parameter $\kappa = (eE_1/\omega)/(m\dot{z}_0)$, ($<0.1$) the impulse transmitted to the particle by the radio frequency RF field (with average strength E_1 across the gap) divided by the free particle momentum $m\dot{z}_0$. Results can be interpreted as if the particle interacts in the gap mainly with those waves traveling with its own velocity. Relativistic corrections (due to the magnetic RF field and the mass variation) are of the order $\kappa \beta^2$. There are some chapters of an introductory nature. One deals with the motion of a proton in a uniform time-harmonic field. In another are described the methods of solving equations of motion approximately and the thin lens approximation. At the end are given tables of beam dynamics coefficients and of non-relativistic and relativistic beam dynamics difference equations across the whole gap and across the first half of it. (auth)

27902 (CERN–69-5) AGS: THE ISR COMPUTER SYSTEM FOR SYNCHROTRON DESIGN AND ORBIT ANALYSIS. Keil, E.; Strolin, P. (European Organization for Nuclear Research, Geneva (Switzerland)). Mar. 25, 1969. 45p. Dep.

AGS, a package of FORTRAN programs, is described which performs the following tasks frequently occurring in the design of Alternating Gradient Synchrotrons. It computes the linear transformation matrices of a string of elements—the "structure." It calculates the betatron and closed orbit functions of the structure. It modifies the parameters of the structure such as to achieve e.g., specified Q values, to match insertions into the structure, etc. It tracks sets of particle trajectories through the structure or parts of it, both in the horizontal and vertical plane. In this mode closed orbit bumps may be included. It finds the closed orbit, when elements are displaced, either by specified amounts or in various random fashions. It computes the coordinates of the equilibrium orbit. It designs closed orbit bumps, both in the horizontal and vertical plane. Certain non-linear effects may also be calculated with the program. Output may be printed on paper or written onto tape for use by subsequent programs. In some cases output may be plotted. (auth)

27903 (CERN–69-6) RESONANT EXTRACTION FROM THE CERN INTERSECTING STORAGE RINGS. Strolin, P. (European Organization for Nuclear Research, Geneva (Switzerland)). Mar. 26, 1969. 43p. Dep.

In order to provide a greater flexibility to the time structure of the external proton beams, proton pulses accelerated by the CERN Proton Synchrotron could be temporarily accumulated into one of the Intersecting Storage Rings (ISR) and then extracted with the desired spill-rate, during the time interval before injection of the successive proton pulse. In particular beams having a duty cycle close to unity could be obtained. The features and the expected performances of a resonant extraction system from the ISR, suitable for this beam buffering operation, are described. The use of a third-order resonance is envisaged. Theoretical studies of the particle dynamics and methods of numerical computations are reported. (auth)

27904 (CERN–69-8) PROTON RESONANCE CALIBRATION AND FIELD STUDIES OF THE CERN MUON STORAGE RING MAGNET. Brown, R. C. Armstrong (European Organization for Nuclear for Nuclear Research, Geneva (Switzerland)). Apr. 30, 1969. 88p. Dep.

The precise measurements needed on the magnetic field of the Muon Storage Ring for its use in the measurement of the anomalous magnetic moment of the muon are discussed. The development of a proton resonance magnetometer, whose frequency is "locked" to variations of the magnetic field by a servo-system, and its use to determine relative and absolute field levels at a precision of 1 part in 10^5 or better are described. This leads to a consideration of the reproducibility of the magnetic field itself at these levels of precision. Other instruments for the stabilization of the field level in the magnet, for the measurement of the median plane, and of skew gradient components in the field, are also covered. The question of the closed orbit is considered, and the influence of perturbations in the field distribution on the form of the closed orbit is derived. The acceptance of the magnet as a storage ring is then calculated. Finally, the development of a program which analyzes the measured magnetic field in terms of sets of harmonic coefficients is described. Particles introduced into this mathematical "model" of the magnet can be followed for many orbits. By this method various aspects of the problem of beam loss after injection can be studied. (W.H.K.)

27905 (CERN-Trans–69-3) PROGRAM OF EXPERIMENTAL STUDIES WITH THE NEW SERPUKHOV ACCELERATOR. Sulyaev, R. M. Translated into French by A. Golovanoff (CERN, Geneva, Switzerland), from Vestn. Akad. Nauk SSSR, 38: No. 8, 76-81(Aug. 1968). 12p. (In French). Dep.

The various experimental studies which can be performed using the Serpukhov accelerator include the behavior of certain physical dimensions at increased energies, study of the internal properties of interactions and decays, treatment of the properties of particles having high energies in the study of properties of matter at small space–time intervals, the structure of elementary particles, and neutrino physics. Experiments using the internal proton beam include proton–proton scattering, and the Dirac monopole. Also meson (π), meson (K), and antiproton interactions can be studied. (J.F.P.)

27906 (LA–4087) PROCEEDINGS OF THE SECOND LAMPF USERS MEETING, JANUARY 16–17, 1969. Agnew, Lewis; Harper, Katherine H. (ed.) (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. 70p. (CONF-690112). Dep. CFSTI.

The present status of the design and construction of the LAMPF accelerator and experimental facilities is described. Also, informal user study sessions on experiments and facilities are outlined. (W.H.K.)

27907 (N–69-10922) THE 2-GeV LINEAR ELECTRON ACCELERATOR AT THE KHARKOV PHYSICOTECHNICAL INSTITUTE. Polushkin, Andrey (Library of Congress, Washington, D. C. Aerospace Technology Div.). Oct. 1968. 10p. CFSTI.

Parameters, operating principles, maintenance, building and out-building layout for the 2 GeV linear accelerator which has been in operation since 1966 are described. The injection, accelerating, rf pulse supply, vacuum and focusing systems are discussed. In addition, the accelerator control and the output beam shaping system are examined, and the characteristics of the accelerated beam are given. (auth) (STAR)

27908 (N–69-13871) DEVELOPMENT OF AN ISOTROPIC RADIATION SIMULATOR. Katz, Lester (National Aeronautics and Space Administration, Huntsville, Ala. George C. Marshall Space Flight Center). Sept. 11, 1968. 20p. (NASA-TM-X–53780). CFSTI.

Films for spacecraft use, which are sensitive to isotropic background radiation, are usually tested by exposure to high-energy particles emanating from an accelerator. Since the particles move in essentially parallel paths, the film is not irradiated in an isotropic mode. Laboratory use of the device described furnishes a method to expose emulsions and other radiation-sensitive items to an isotropic distribution of radiation that is limited to half-space exposure. (auth) (STAR)

27909 (N–69-14398) CHARACTERISTICS OF COMPOSITE CARBON RESISTORS USED FOR MEASURING ACCELERATOR TERMINAL VOLTAGES. Stevenson, Frank R.; Gauntner, Daniel J. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Jan. 1969. 13p. (NASA-TM-X–1718). CFSTI.

A voltage-divider board, composed of 1152 22-MΩ composite carbon resistors used to measure the terminal voltage of a 3-MeV Dynamitron, was investigated. The board was calibrated in place by using the ^{9}Be and D photoneutron threshold reactions and a magnetic analyzer. The present calibration of the divider board, made after more than 5 years of extensive accelerator usage agreed within 2 percent with the original factory calibration. The temperature and voltage coefficients of resistance were also measured. Results showed that composite carbon resistors and the techniques described can be applied with confidence to the measurement of high voltage. (auth) (STAR)

27910 (NYO-3863-12) THE "HIPAC" AS A SOURCE OF HIGHLY STRIPPED HEAVY IONS. Research Report 333. Daugherty, J. D.; Eninger, J. E.; Janes, G. S.; Levy, R. H. (Avco-Everett Research Lab., Everett, Mass.). Apr. 1969. Contract AT(30-1)-3863. 24p. Dep. CFSTI.

The HIPAC ion source is a novel device intended to produce very highly stripped heavy ions; the achievement of this objective would permit the acceleration of heavy ions in relatively modest cyclotrons, linacs etc. The problem of stripping heavy ions by successive electron impacts is discussed in general terms. The HIPAC ion source is then described using for illustrative purposes a nominal set of characteristic parameters. A torus 20 cm in major radius is estimated to yield 10^{13} ions/sec of Kr^{20+} or 10^{11} ions/sec of U^{60+}. The current status of experimental work on the concept is briefly reviewed. (auth)

27911 (SLAC-PUB-592) CONTROL AND MONITORING OF THE SLAC ACCELERATOR UTILIZING A PDP9 SYSTEM. Struven, Warren C. (Stanford Linear Accelerator Center, Calif.). Apr. 1969. 8p. (CONF-690510-1). Dep. CFSTI.

From DECUS Symposium, Wakefield, Mass.

A PDP9 system is being installed to supplement the manual controls and visual readout of the SLAC accelerator and to provide data logging for some 3000 points. Initially, malfunctioning klystrons will be sensed and suitable spares will be switched to multiple beams. Switching will be slow at first (up to 0.7 seconds) but a future parallel system will switch klystrons within one interpulse (2.7 ms). Summarized data will be read out weekly or biweekly from the disk. Later, magnetic tape will be used to transfer data from the disk to an IBM 360-91 for extensive off-line data reduction. Beam steering, focusing and spectrum control will be implemented. (auth)

27912 CONTROL SYSTEM OF STABILITY OF THE MAGNETIC FIELD IN EREVAN ELECTRON SYNCHROTRON ELECTROMAGNET BLOCKS. Esin, S. K.; Milovanov, Yu. L.; Minyaev, V. N.; Tumanyan, A. R. (Inst. of Physics, Erevan). Izv. Akad. Nauk Arm. SSR, Ser. Fiz., 3: 260-4(1968). (In Russian).

The system described permits one to expose deviations of the magnetic field in the blocks of the synchrotron magnet. Some examples of such diagnostics are given. The system consists of picking strips and an electronic circuit. (auth)

27913 NONCONTINUAL ACCELERATION EFFECT IN SYNCHROTRON. Kheifets, S. A. (Inst. of Physics, Erevan). Izv. Akad. Nauk Arm. SSR, Ser. Fiz., 3: 265-8(1968). (In Russian).

It is shown that noncontinual acceleration in the synchrotron introduces a longitudinal motion instability when the oscillation number exceeds the maximal one and distorts the longitudinal motion phase orbits. The phase ellipse in the case of linear oscillations tilts for a small angle depending on the ratio of the accelerating voltage to the particle energy. These effects may become essential for a synchrotron with fast acceleration. (auth)

27914 PROJECT OF THE HIGH-CURRENT LINEAR ELECTRON ACCELERATOR. Voronkov, R. M.; Boiko, V. A.; Shmygov, M. V.; Filippova, M. V. At. Energ. (USSR), 26: 348-52(Apr. 1969). (In Russian).

The main features of the project of high-current linear electron accelerator are discussed. The accelerator is capable of producing electron beam current 1 A at 60 MeV during the pulse up to 5.5. microseconds. The accelerator consists of 6 sections; each of them is supplied by pulsed 20 MW klystron under duty cycle of 0.1%. In order to eliminate the beam blow-up phenomena the accelerating structure is made as the short (1.7 m length) constant-gradient corrugated waveguide (a/λ changes from 0.12 at the beginning of the section to 0.1 at the end). $2\pi/3$ mode of operation is used and each disc has four radial slits. Due to the high average beam power (60 kilowatts) some provisions are made for measuring of the beam value and position: the magnetic-inductive type monitors and the splited water cooled collimators. (auth)

27915 THIN-WALLED LIQUID HYDROGEN TARGET. Sannes, F.; Trischuk, J.; Stairs, D. G. (McGill Univ., Montreal). Nucl. Instrum. Methods, 70: 235-6(Apr. 15, 1969).

A double-walled liquid hydrogen target is described. A thin-walled-flask containing liquid hydrogen is surrounded by a larger and stronger flask containing gaseous hydrogen. The counter geometry is such that the solid angle available to scattered protons is uniform throughout the volume of the liquid hydrogen and decreases to zero at the walls of the outer flask. (auth)

27916 INTEGRATOR AND METER WITH LOW IMPUT IMPEDANCE FOR ACCELERATOR BEAM CURRENT. Hakansson, H.; Erlandsson, B. (Univ. of Lund, Sweden). Nucl. Instrum. Methods, 70: 205-8(Apr. 15, 1969).

A current integrator with low input impedance working in the range $10^{-8}-10^{-4}$ A has been designed with solid state operational amplifiers for the measurement of the beam current of a Van de Graaff accelerator. The first part of the integrator can be used as a current meter working in an increased range $10^{-9}-10^{-4}$ A. (auth)

27917 INTENSITY FLUCTUATIONS OF CYCLOTRON MICROSTRUCTURE BEAM PULSES. Linder, W.; Loesel, M. E.; Schatz, G.; Schweickert, H. (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Instrum. Methods, 70: 151-6(Apr. 15, 1969).

Measurements of the intensity distribution of microstructure beam pulses from an isochronous cyclotron are described. Typical intensity distributions result in an increase of the chance coincidence rate of coincidence experiments by a factor of 2 over the ideal case of equally sized bursts. Among other factors stray frequencies in the rf may contribute to these intensity fluctuations. (auth)

27918 METHOD AND APPARATUS FOR INTERLEAVED CHARGED PARTICLE ACCELERATION. Westcott, C. H. (to Atomic Energy of Canada Ltd.). Canadian Patent 805,240. Jan. 28, 1969.

A method is described of accelerating either positive or negative charged particles which are grouped into first bunches and then accelerated by an alternating electric field. An improvement consists of bunching charged particles of opposite sign and about the same charge/mass ratio as the other particles into second bunches. These are spaced from the first bunches by a phase difference of about π radians with respect to the accelerating field frequency and then accelerating these second bunches in this field. The first and second bunches are separated after acceleration in the field. The alternating field accelerator is an Alvarez linear accelerator. Other associated equipment such as focusing devices is also described. (CANADA)

27919 METHODS TO ACCELERATE HEAVY IONS WITH CYCLOTRONS. Boettger, Otto. Wiss. Ber. AEG-Telefunken, 41: 105-13(1968). (In German).

Some proposals have already been made for the acceleration of heavy ions as, for example, the Omnitron, a synchrotron with a storage ring with which all particles may be accelerated. If we discuss here further proposals based on cyclotrons then it is with the conviction that no further developments are needed for the design of cyclotrons for the acceleration of heavy ions. Since the design of such accelerators is not an end in itself but a means to an end, all the possible methods must be taken into consideration to find the most economical solution by comparison. First of all, two cyclotrons are discussed, one for the acceleration of particles up to an atomic weight of 20 with a machine radius of approx. 1.25 m, the other for particles up to an atomic weight of approx. 40 (machine radius approx. 1.75 m). The maximum energies obtained with these machines are compared with the maximum energy reached by a tandem accelerator. In addition proposals are made for the acceleration of particles up to atomic weight 92 up to approx. 7 MeV/nucleon by connecting two machines in parallel. The possibility of connecting a tandem accelerator and cyclotron in series, is also discussed briefly. (auth)

27920 FLUX CONCENTRATOR (Engineering Materials). (Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science). (CAPE-1873).

44 drawings.

A liquid-nitrogen-cooled pulse flux concentrator magnet designed to be used in the measurement of the magnetic moment of the short lived Λ hyperon is described. The magnet has primary and secondary windings to produce a high magnetic field in the bore. Stacked discs forming radial slits are sequentially spaced in progressive rotation from each other. Pre-fabricated coils are provided between each disc. (For details see TID-4100 Suppl. 54; see also 22: 29459) (F.S.)

27921 A DEVICE FOR THE MEASUREMENT OF THE BETATRON OSCILLATION FREQUENCIES IN A STRONG-FOCUSING SYNCHROTRON. Esin, S. K. (Inst. of Physics, Erevan). Izv. Akad. Nauk Arm. SSR, Ser. Fiz., 3: 342-7(1968). (In Russian).

A resonant system for the measurements of betatron frequencies is calculated. Numeral results corresponding to the parameters of the 6 GeV Erevan synchrotron are presented. The practicable accuracy of the measurement is about 0.2%. (auth)

27922 USKORITELI. VYPUSK X. (Accelerators. Issue 10). Val'dner, O. A. (ed.). Moscow, Atomizdat, 1968. 248p.

Twenty nine articles are presented on the theory and computations of linear electron accelerators. Methods for calculating periodical wave guides used as acceleration systems and results of experimental studies of dispersion properties of hybrid waves in spherical diaphragm wave guides are discussed. The design and construction of large synchrophasatrons, dynamics of particle injection, and calculations of pulse feeding chains for high-frequency generators are covered in several articles. Magnetic analyzers for recording energy spectra of electrons on oscillographs, methods for increasing the efficiency of voltages for quadrupoles, and certain characteristics of linear electron accelerator radiation are described and discussed. (R.V.J.)

27923 THE LINEAR ACCELERATOR AT BCMN. Allard, C. (EURATOM, Geel, Belgium). Bull. Belgicatom, 13: No. 3/4, 40-4(Oct.-Dec. 1968). (In French).

The BCMN linear accelerator is an electron accelerator, producing through the use of a uranium target a flux of pulsed neutrons. It is designed to make neutron measurements to furnish theoretical data necessary for designers of reactor projects. The history of the development of linear accelerators is outlined. The most important elements of accelerators are described briefly. The characteristics of the BCMN accelerator are compared with those of other accelerators. (J.S.R.)

27924 AT THE PROTON SYNCHROTRON AT CERN: IN THE NEIGHBORHOOD OF 10^{13} PROTONS PER SECOND. [PART II]. Bayard, Olivier (CERN, Geneva). Ind. At., 13: No. 1-2, 51-7(1969). (In French).

The factors considered in the selection of the injector for the CERN proton synchrotron are reviewed. The principal parameters of the booster are given. The improved PS is described. (J.S.R.)

27925 IMPROVEMENTS RELATING TO PARTICLE ACCELERATORS. Gibbons, William Frederick; Watkin, Kenneth (to Ferranti, Ltd.). British Patent 1,150,337. Apr. 30, 1969. Filed Jan. 28, 1967.

Reference is made to accelerators of the betatron, synchrotron or linac types. When such accelerators are of large size the tubular vacuum chamber is usually built up from a number of sections of electrically insulating material. An all-metal construction is not suitable since it would allow the circulation of electric currents, with undesirable results. Ceramic and glass chambers are expensive, because of the required close dimensional tolerances. Epoxy resins are cheaper, but have the disadvantage that they evolve gases under charged particle irradiation, leading to defocusing of the particle beam. A tubular chamber is described which has a number of metal sections each of which comprises a metal tube divided longitudinally into at least two members separated by strips of ceramic insulating material, to which the members are secured in a vacuum-tight manner. (auth)

27926 THE PREPARATION AND MEASUREMENT OF VERY THIN VYNS FILMS. Volkar, M. A.; Wolke, R. L. (Univ. of Pittsburgh). Rev. Sci. Instrum., 40: 849-51(June 1969).

The preparation and measurement of thin films of the polyvinyl chloride–acetate copolymer known as VYNS, made by spreading a cyclohexanone solution of the polymer over a water surface, are described. These films are useful as radioactive source backings, as absorbers of nuclear radiations, as accelerator targets, and for other applications in radiochemistry and nuclear physics. (W.H.K.)

27927 MONOENERGY CYCLOTRON. Glazov, A. A.; Denisov, Yu. N.; Dzhelepov, V. P.; Dmitrievskii, V. P.; Zamolodchikov, B. I.; Zaplatin, N. L.; Kolga, V. V.; Polikanov, S. M.; Soloiev, V. G. (Joint Inst. for Nuclear Research Dubna, USSR). Nucl. Instrum. Methods, 70: 274-8(May 1, 1969).

The possibility of producing accelerated p, d, α, ^{3}He, ^{6}Li beams with small energy spread (10^{-4}) has been considered at 60–80 MeV maximum proton energy and about 100 μA intensity. Design parameters for an isochronous cyclotron are presented. (auth)

27928 SPACE CHARGE DISPERSION OF DRIFTING BEAMS. Gallagher, W. J. (Applied Radiation Corp., Walnut Creek, Calif.). Nucl. Instrum. Methods, 70: 301-5(May 1, 1969).

The generally accepted solution for beam spreading due to space charge forces is reconsidered. An exact, relativistic solution is obtained in the stationary frame of the beam (and transformed into the laboratory frame) as well as the direct electromagnetic solution in the laboratory frame. Departures from the universal beam spreading curve are noted; beam expansion is slightly larger than formerly given. (auth)

27929 AN APPROXIMATE CALCULATION OF THE AXIAL POTENTIAL IN ELECTROSTATIC LENSES. Bosi, G. (Univ., Moncton, Can.). Nucl. Instrum. Methods, 70: 317-19(May 1, 1969).

An approximation method yielding an accuracy picture of the fieldform in the neighborhood of the symmetry axis in lens systems is described. Some simple problems are solved and formulae are compared with results from already known approaches. (auth)

27930 RESONANCE-FREE METHOD FOR THE EXTRACTION OF HIGH PARTICLE CURRENTS FROM CYCLOTRONS. Mahrt, Rudolf; Boettger, Otto. Wiss. Ber. AEG-Telefunken, 41: 55-63(1968). (In German).

In the course of scientific research the requirement is constantly growing for higher extracted beam currents from cyclotrons. Nuclear physicists generally demand beams of variable energy and particle type. On the one hand machines are concerned for the generation of high proton and/or deuteron beam currents in which each beam loss leads to high thermal and radiation loads and, on the other hand, for machines to accelerate ions which–even when external ion sources are used–may be produced only in small quantity, whereby it is important to extract the accelerated particles free of losses. With such machines one has frequently no separate orbits at the edge region so that it is impossible to use electrical septa without prior path extension due to the beam losses across the septum material. The previously known methods for septum and resonance extraction are sketched with their merits and drawbacks, and are compared to the new resonance-free extraction method. The shift of particle paths under the influence of individual field harmonics and their derivations are described. The interaction of various field harmonics is described, and the drawbacks are explained which are connected with the resonance method. The resonance-free extraction method is explained and its implementation is stated for variable energy machines. An estimation of the admissible phase width for single-turn extraction is presented, and a design example and results of Runge Kutta calculations are described of resonance-free extraction from a variable-energy machine for the acceleration of max. 20 MeV for protons. By means of the described method it is possible to extract virtually loss-free from machines up to at least 20 MeV/nucleon, whereby the energy/nucleon range extends down to virtually zero. The method should also yield great advantages for machines in which single-turn extraction is impossible due to too wide phase width or due to space charge influences, as well as for synchrotrons with their narrow path spacings at the edges. (auth)

27931 CHARGED-PARTICLE ACCELERATOR. Yamamoto, Makoto (to Japan Electron Optics Lab. Co.). Japanese Patent 1969-2680. Feb. 4, 1969. Filed May 19, 1965.

An improved method of conditioning is proposed for the multistage accelerating tube of a charged-particle accelerator. The switching with regard to the feeder circuit is minimized, and the voltage distribution is not much affected. Moreover, the operation of acceleration and conditioning can be done outside the tank. The gaps between electrodes in the accelerating tube are connected in parallel by means of two condenser columns. The two condenser columns can be connected or separated on the side of high potentials. A switching device is installed at the ground-side terminal of the columns. Through this device, an a. c. source can be connected to the ground-side terminals. The high-potential side of the two columns are separated only when an a. c. source is connected to the ground side of the columns. (NSA of Japan)

27932 1969 PARTICLE ACCELERATOR CONFERENCE, WASHINGTON, D. C., MARCH 5-7, 1969. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 1-1120(June 1969). (CONF-690308).

Separate abstracts were prepared for each of the 280 papers presented. (W.H.K.)

For abstracts of individual papers see: 26432, 26433, 26550, 26579, 26580, and 27933–28207.

27933 ACCELERATORS AND THE WORLD AROUND US. Robinson, Denis M. (High Voltage Engineering Corp., Burlington, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 1-4(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

To what extent have accelerators and the basic science associated with them been useful to the public as a whole; to the layman, to the national life? An impressive answer can be given; the contribution has been enormous; it is well documented and acknowledged among scientists. In hard economic terms, it has had a greater payoff than any science investment yet. However, that remarkable record has not saved university and national accelerator programs from being hurt by the capital and operating budget limitations of recent years. When we ask for money support, the question comes back: "What have you done for us lately?" or "What are you doing for health, cities and air pollution?" Scientists engaged in basic work and teaching know that science must be supported anyway and they reiterate what we all know: that a large proportion of the great breakthroughs of technology come as a result of basic scientific inquiry, but that useful applications are inherently unpredictable. This difference of aim and priority is nothing new. It has been the rule rather than the exception in the past and in other countries. The pure scientist, like the artist, has never really been understood by the men and institutions who supported him at the time. This dichotomy between people seeking immediate solutions to present problems and those leading the search for knowledge of the physical world is itself basic and necessary. We can learn to keep it working for us as it has in the past. To do this we must have a united viewpoint that can be expressed and understood by the press, the public, and the Congress. Basic science and its applications must have equal priority and together they must have their essential place in the national scheme. (auth)

27934 THE 70-GeV PROTON SYNCHROTRON. Ado, Yu. M. (Inst. of High Energy Physics, Serpukhov, USSR). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 5-11(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

27935 THE 200-GeV ACCELERATOR. Collins, T. L. (National Accelerator Lab., Batavia, Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 12-14(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

A discussion of construction plans for the 200-GeV accelerator with emphasis on the overall design and site master plan is presented. (auth)

27936 COLLECTIVE METHOD OF PROTON ACCELERATION. Sarantsev, V. P. (Joint Inst. for Nuclear Research, Dubna, USSR). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 15-24(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

27937 ELECTRON-RING ACCELERATOR. Keefe, D. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 25-8(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Intensive studies relating to electron rings as vehicles for accelerating protons are under way at the Lawrence Radiation Laboratory; an experimental program has been in progress for about a year. With the 4-MeV 0.1-amp Berkeley linac, low-current rings were formed and compressed from a radius of 20 to 7 cm. In more recent experiments at the 3.3-MeV 200-amp Astron injector in Livermore high-current rings were successfully compressed to a final radius of 3.5 cm and a final energy of 19.0 MeV. The continuing program of electron-ring research is described. (auth)

27938 CONSIDERATIONS ASSOCIATED WITH HIGH-CURRENT ACCELERATOR ION SOURCES. Sluyters, Th. J. M. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 29-34(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The advance in ion source technology for dc beams was summarized by G. Kelley during the previous accelerator conference. In the present report the emphasis is on pulsed ion sources for accelerator use. Construction of reliable operating sources is well under control in most laboratories. Beam currents are available up to one Ampere; this seems to be more than sufficient for present and near future machines. The accelerator ion source designer needs also to create good beam optical qualities of the ion emitter. Only a few of the large number of ion source publications (about 50 per year) discuss this problem (Orsay, Saclay and Brookhaven). The operating parameters of accelerator ion sources are summarized with references for more detailed information. The physical mechanisms of initial shaping and control of the ion emitter in duoplasmatron sources and related problems are discussed. (auth)

27939 A MASS ANALYZER SYSTEM FOR THE HIGH VOLTAGE TERMINAL OF A VAN DE GRAAFF HEAVY-ION ACCELERATOR. Ruedenaur, F. G. (Massachusetts Inst. of Tech., Cambridge). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 35-7(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

A computer analysis of an electromagnetic mass analyzer system which will be mounted in the high voltage terminal of a planned 3-MeV Van de Graaff heavy-ion accelerator at MIT has been performed. Since one of the main fields of application of this new facility will be ion implantation, a stigmatic focusing analyzer with high transmission is required. It is shown that a magnetic sector field which is formed by plane inclined pole faces meets both these requirements. Second order ion optical calculations for this type of field are given and compared with two more conventional alternatives of stigmatic focusing analyzers, namely the homogeneous field fringe field focusing magnet and the rotationally symmetric field with logarithmic field gradient $n = \frac{1}{2}$. The complete ion-injector system which will consist of a high temperature metal ion source, an extraction and focusing system, and a stigmatic double-focusing mass analyzer will have a total weight of about 400 pounds and be capable of unit mass resolution at least up to mass number 150. (auth)

27940 ION SOURCE FOR NEGATIVE HEAVY IONS. Mueller, M.; Hortig, G. (Max-Planck-Inst. for Nuclear Physics, Heidelberg). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 38-40(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

An ion source based on the secondary ion emission from a rotating plate covered with cesium yielded negative ion currents of more than 10 μA of Ag^- and Au^- in a first test. Technical details and recent results on different materials are presented. (auth)

27941 ION SOURCE MODIFICATION FOR He^- IONS. Wells, G. F.; Johnson, J. W. (Oak Ridge National Lab., Tenn.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 41-2 (June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The charge exchange canal of the standard HVEC negative ion source has been modified to accept a 250-Watt heater, metal-vapor source, and cooled baffles. The new canal is designed to utilize the alkaline earth metals (Mg, Ca, Ba, Sr), all of which produce sufficient vapor for charge exchange below their melting points. Experience indicates calcium to be the best He^- ion producer; 1.2 μa of He^- ions and 0.7 μa of He^{++} ions are obtained in the analyzed beam at 10 MeV. All the metals tried are much superior to the gas canal previously used. (auth)

27942 INERT GAS ION BEAMS FROM A DUOPLASMATRON ION SOURCE. Wells, N.; Hanley, P. R. (Radiation Dynamics, Inc., Westbury, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 43-5(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Operational characteristics of a duoplasmatron ion source were examined for milliampere positive ion beams of helium and argon. Ion beam current was measured as a function of extraction voltage for various source arc and source magnet currents. With the source parameters fixed, the data exhibits a critical voltage, above which the target current saturates and is independent of extraction voltage. This saturation current is linearly dependent on the source arc and source magnet currents. Below the critical voltage, the target current can be described by a $V^{3/2}$ dependency on extraction voltage. These observations indicate that the ion current extracted from the plasma is only dependent on the source parameters and thus on the ion flux through the anode aperture. Results are compared for strong-field and weak-field extractor electrodes, which confirm that the total current extracted from the plasma is independent of the extraction field strength. (auth)

27943 TEST OF LASL ION SOURCE WITH 200-kV PIERCE ACCELERATING COLUMN. Emigh, C. R.; Meyer, E. A.; Mueller, D. W. (Los Alamos Scientific Lab., N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 46-50(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

A 200-kV test stand has been constructed for evaluation of a high-duty factor ion source capable of producing a 30-mA beam of protons of high quality (emittance $<\pi$ cm-mrad). The ion source is a Von Ardenne duoplasmatron with a large expansion cup. The beam extraction is accomplished by an exact Pierce geometry accelerating column. The anode of the Pierce column is biased to the plasma potential to reduce rim distortion, which usually is associated with large plasma extraction surfaces. Special cooling is necessary for this high-duty factor ion source. The test stand vacuum system uses a 1000-l/sec ion pump which is capable of continuously handling the 2 cc-atms/min hydrogen throughput of the ion source. The pumping cells of the ion pump are expected to have a useful life in excess of 4000 h. The test stand can be operated completely by computer control. (auth)

27944 THE HIPAC AS A SOURCE OF HIGHLY STRIPPED HEAVY IONS. Daugherty, J. D.; Eninger, J. E.; Janes, G. S.; Levy, R. H. (Avco Everett Research Lab., Everett, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 51-8(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

In the HIPAC ion source concept, a cloud of electrons ($n_e \sim 2 \times 10^{10}$ cm^{-3}) is contained in a toroidal vacuum chamber (minor radius ~ 10 cm, major radius ~ 50 cm) by an azimuthally symmetric magnetic field (~3 kG). The azimuthally symmetric space charge (of the electrons) creates a topologically closed potential well in which ions can be trapped ($Z_{eff} n_i \sim 2 \times 10^9$ cm^{-3}). In addition, the electron cloud rotates perpendicular to the magnetic field with a characteristic speed $E/B < 10^{10}$ cm/sec. This translational motion of the electrons allows one to consider the electron cloud as equivalent to a 100-MW beam whose power is almost wholly reactive (energy ~1 joule, rotational frequency ~100 MHz). The ions do not rotate with the electrons and will therefore become highly stripped in times like 0.1–10 secs. Mean production rates of stripped ions are expected to be 10^{13} ions/sec for Kr^{+20} or 10^{11} ions/sec for U^{+60}. The major problems involved in matching this ion source to a variety of accelerators (cyclotrons, linacs, potential drop machines, synchrotrons) are briefly reviewed. The current status of theoretical and experimental work on the concept is discussed in an adjacent paper. (auth)

27945 DYNAMICS OF ELECTRON BEAM FLOW FROM PULSED, HIGH CURRENT FIELD EMISSION CATHODES. McNeil, W. R.; Uglum, J. R. (Ion Physics Corp., Burlington, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 70-4(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

A great deal of data has become available concerning the impedance characteristics and current density profile of beams produced by pulsed electron accelerators. A computer program has been used to explain the details which are now known for a specified cathode geometry. The same program can also be used to predict the performance of other cathode geometries. The program uses the Lorentz force equation coupled with Maxwell's equations, including the electron beam's interaction with its own magnetic field, to numerically compute the beam flow in a self-consistent manner. Detailed analysis of a 100-ohm, 2-MV cathode is presented, and the numerical results are compared with experimental data. It was found that both the cathode impedance, and electron beam flow, could only be accounted for if the emission from the cathode is assumed to be space charge limited. A plausible reason for this limitation is put forward. (auth)

27946 A MONTE-CARLO MODEL FOR THE HEAVY-ION CHARGE CHANGE ACCELERATOR. Hortig, G. (Max-Planck-Inst. for Nuclear Physics, Heidelberg). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 75-7(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Monte-Carlo model studies for the heavy-ion accelerator considering charge change, scattering, and energy loss in the charge change media are presented. The assumptions for this model and results of the studies concerning limiting effects for the maximum energy, beam diameter, and transmission are discussed. (auth)

27947 ION OPTIC SYSTEM FOR THE HEAVY-ION CHARGE CHANGE ACCELERATOR. Schechter, M.; Hortig, G.; Spillecke, H. (Max-Planck-Inst. for Nuclear Physics, Heidelberg). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 78-80(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

An achromatic ion optic system particularly suited for the heavy-ion charge change accelerator is presented. The system consisting of a straight strong focusing section terminated by two three-component mirrors has been optimized to obtain stability of the ion trajectories in the full range of achromacy. The system and the optimization procedure are discussed. (auth)

27948 TANDEM ACCELERATORS. Wegner, H. E. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 81-9(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The latest improvements in the design and performance of multistage electrostatic accelerators are reviewed. Drawings and photographs are used to illustrate the progress of new accelerators under design and construction in this country. Particular attention is given to the 15-MV Model-TU and 4-MV high current tandem Van de Graaff accelerators of the High Voltage Engineering Corporation; the Dynamitron high current tandem accelerator of Radiation Dynamics, Incorporated; and the 5-MV source injector and 8.5-MV vertical tandem that constitute the 22-MeV three-stage Pelletron accelerator of the National Electrostatic Corporation. The dynamic capabilities of these new machines and the important role that they will play in the study of nuclear structure physics are described. Finally, there is a brief photographic tour through the large three-stage facilities in the United States including those at Los Alamos Scientific Laboratory, the University of Washington, and at Brookhaven National Laboratory. (auth)

27949 THE TANDEM DYNAMITRON. Hanley, P. R.; Cleland, M. R.; Mason, C. F.; Morganstern, K. H.; Thompson, C. C. (Radiation Dynamics, Inc., Westbury, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 90-5(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

A two-stage tandem accelerator system, powered by a Dynamitron high voltage generator, is currently undergoing factory tests. The parallel-coupled cascaded rectifier generator is designed for a 5-mA current capability at maximum voltage, to accommodate a terminal-mounted duoplasmatron ion source for single stage operation. A large gas stripping canal replaces the ion source assembly for two stage operation. Titanium sublimation pumps are mounted in the terminal to ensure acceptable vacuum conditions in the fully shielded acceleration tubes. Guaranteed specifications of this model series are 100-μA targeted proton current at 9 MeV. The injector has delivered more than 200 μA of H^- and the generator has operated at 5 MV during initial testing. Some novel features of this new tandem system are described and operational performance characteristics measured during factory testing are reported. (auth)

27950 SUPPRESSION OF VERTICAL JITTER OF THE BEAM FROM AN INCLINED FIELD TUBE 3-STAGE FN-TYPE TANDEM VAN DE GRAAFF ACCELERATOR. Caling, Nancy J.; Fauska, Harold; Schmidt, Fred H. (Univ. of Washington, Seattle). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 96-7 (June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The beam from a tandem accelerator with vertically inclined field tubes undergoes a rapid up and down motion, or jitter. The jitter is caused by an irregular charge density transported by the belt, which induces fluctuating potentials on the inclined electrodes. The beam jitter is thus a complex pattern repeated each belt cycle; its magnitude varies from ¼ to one beam width at the image of the first quadrupole lens. For some experiments the beam jitter causes undue scattering from defining apertures. Our suppressor system senses the jitter on a pair of adjustable slits placed at the quadrupole image. The correction signal is sent to deflection plates located just downstream from the quadrupole. These plates were originally used for vertical steering; this is now accomplished by biasing the quadrupole. The suppressor reduces the jitter to 10% or less of a beam width, and thus reduces the beam spot area on target by 10 to 50%. The system has been used successfully for 22-MeV α particles, and for protons from 8 to 20 MeV. (auth)

27951 MAGNETICALLY SUPPRESSED ACCELERATOR TUBES FOR ELECTROSTATIC ACCELERATORS. Howe, F. A. (Atomic Energy Research Establishment, Aldermaston, Eng.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 98-9(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Magnetically suppressed tubes of the design detailed in the paper presented at the 1967 Conference have now been installed and operated in both single and tandem stage electrostatic accelerators. The results of these operations are presented and discussed, together with various other aspects of design and pre-installation testing. (auth)

27952 A STUDY OF VACUUM REQUIREMENTS FOR THE ACCELERATION OF HEAVY IONS IN AN MP TANDEM VAN DE GRAAFF. Chmara, F.; Ryding, G.; Shaw, J. (High Voltage Engineering Corp., Burlington, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 100-4(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Accelerator vacuum systems, which are adequate for the acceleration of intense beams of light elements, may not be suitable for heavy ions which have large charge changing cross sections. An MP tandem with a carbon foil terminal stripper was used to accelerate iodine ions. The attenuation of the unique energy beam components due to unwanted charge changing collisions was measured by energy and magnetic analysis of the accelerator output. The effects of terminal pumping, vacuum deterioration due to added gas, and reduction of the accelerator tube conductance were studied with particular attention to high charge states. Under typical conditions with a 6-MV terminal and pressure ~4 × 10^{-6} torr in the terminal region, the total beam attenuation was ~20%. (auth)

27953 WIDE-RANGE VAN DE GRAAFF PULSER. Rogers, E. J. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 105-6(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

A unique system for producing variable length electron pulses from a Van de Graaff accelerator has been developed; it provides pulses with duration continuously variable from less than 0.2 μsec to an unlimited upper value. The very wide range is achieved by the use of a two-channel control system in which separate light signals turn the beam on and off. The two-channel technique greatly relieves the band-width requirements on the light source and amplifying circuitry in the high voltage terminal. The electron gun control grid, because of its capacitance and large voltage swing, requires a peak power approaching 1 kW to produce switching time of the order of 60 nsec. The high transient power is supplied by a pair of blocking oscillators using small receiving tubes. Their average dissipation is low because they are active only during the switching periods. A single-tube amplifier driven by a flip-flop holds the grid at the required on or off level after switching has been accomplished. Again, a small receiving tube may be employed because the amplifier, not being required to provide switching power, can be operated at low current with a very high load resistance. (auth)

27954 SELECTION OF A VAC-ION PUMP FOR A TERMINAL ION SOURCE. Benjamin, J. A. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 107-8(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

An 800-l/s electrostatic ion pump and a 500-l/s magnetic triode ion pump have been tested to determine which would be most suitable for pumping the hydrogen gas emanating from a duoplasmatron ion source. The ion source and pump will be located in the terminal of a HVEC Type MP tandem accelerator. The two pumps were mounted on a pump test stand with a manometer, two needle valves, and two ion gauge controllers. The hydrogen flow to each pump was increased slowly until the pump was near the point of pressure instability. Flow rates and pressures were recorded for about 1000 hours. The performance of the magnetic triode ion pump was superior to that of the electrostatic pump. The magnetic triode ion pump is presently undergoing another test, pumping the hydrogen gas from a duoplasmatron ion source test stand. Pumping speed measurements, modes of failure, and other details of these continuing tests will be presented. (auth)

27955 A HIGH SPEED GAS-HANDLING SYSTEM FOR THE BROOKHAVEN NATIONAL LABORATORY THREE-STAGE TANDEM VAN DE GRAAFF FACILITY. Minati, K. F. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 109-10(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

A high speed gas handling system for the insulating gas of two MP Van de Graaff accelerators has been installed at the Brookhaven National Laboratory three-stage facility. The system was designed to complete all phases of the gas handling function (except drying) in less than 4½ hours. A complete pumping cycle consists of pumping gas to storage, ventilating the tank, evacuating air from the vessel and gas filling. To avoid thermal shock to the fragile structure within the 11,000 cubic foot accelerator vessel, the gas cycling should be accomplished with a temperature change of less than 10°F per hour and a maximum temperature gradient within the tank of less than 10°F. Heat load calculations indicated that an external heat exchanger, recirculating blower, and temperature controls were required. The pumping speed of the reciprocating gas compressor has been substantially improved, without any increase in horsepower, by utilizing a high pressure first-stage cylinder designed to accept accelerator tank pressure throughout the pumping cycle. A description of the mechanical equipment and temperature controls will be presented, together with some actual performance data. (auth)

27956 HIGH VOLTAGE INSULATORS FOR PARTICLE ACCELERATORS. Srivastava, K. D. (Univ. of Waterloo, Ont.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 111-12(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

In modern high energy particle accelerators many component parts and devices, e.g., dc injectors, electrostatic inflectors, beam choppers and velocity separators, operate in vacuum at high voltages. Since the surface voltage stress attainable across insulators is generally lower than across plane gaps, the physical size of the high voltage apparatus is governed by the high voltage performance of support insulators in vacuum. This performance is affected by the residual gas pressure and composition, insulator shape and material, the design of the triple (insulator-electrode-vacuum) dielectric junction and the nature of the applied voltage, pulsed or dc. The relative importance of the above factors is discussed in the light of experience with NIMROD, the 7-GeV proton synchrotron, and with the design of a dc injector for the proposed Chalk River Intense Neutron Generator. Some results for ceramic oxide conductive surface coatings are also discussed. (auth)

27957 ACCELERATION OF INTENSE POSITIVE ION BEAMS AT MEGAVOLT POTENTIALS. Cleland, M. R.; Hanley, P. R.; Thompson, C. C. (Radiation Dynamics, Inc., Westbury, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 113-16(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The long range objective of the ion accelerator development program at RDI is to achieve a proton beam current of 5 to 10 mA at 3 to 5 MeV energy. Present performance is limited to 3 mA of mixed hydrogen ions at 3 MeV and 2 mA at 4 MeV, despite the fact that both ion source and high voltage generators are capable of 10-mA service. Symptoms of excess ion beam loading are: rapidly increasing vacuum, x-ray production, leakage current, and beam halo. These observations can all be explained through the mechanism of scattering of the beam by residual gas in the acceleration tube. This effect is regenerative because scattered particles release more gas from the tube electrodes. The problem has been substantially reduced by a titanium sublimation pump at the high voltage terminal. In addition to the pump, a crossed-field mass analyzer has been operated in the terminal. Comparative data on machine performance with analyzed beams have shown that the loading effects are more severe with molecular ions. The data suggest that the goal of 5 to 10 mA of protons can be achieved through the proper use of vacuum pumping and mass analysis prior to acceleration. (auth)

27958 HIGH VOLTAGE DC POWER SUPPLIES FOR BEAM INJECTORS. Reinhold, Guenter (Emile Haefely and Co., Zurich). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 117-18(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

During 1969 three 850-kV dc power supplies will come into operation for beam injection into high energy accelerators now under construction at LASL, BNL, and NAL. These air-insulated power supplies use a symmetrical cascade generator and an accelerator structure which will accept the ion source and its auxiliary equipment. A 15-kW motor-generator set with an insulating shaft is used to energize the equipment at high voltage potential. The dc power supplies are rated at a maximum operating voltage of 850 kV dc and are designed to provide current pulses from 0.1 to 0.5 A with pulse lengths from 500 to 100 μsec at repetition rates from 120 to 10 c/s. The overall stability of the accelerating voltage between and during the pulses is better than 1 × 10^{-3}. A fully electronic ac supply and coarse regulating system are used to energize the cascade generator and to stabilize its dc output voltage. The fast regulation from the beginning until the end of the steep current pulses is achieved by a regulating system that utilizes a bouncer. (auth)

27959 PRESSURIZED 1-MeV ELECTRON ACCELERATOR OF THE TWIN-TANK DESIGN FOR ELECTRON MICROSCOPY. Reinhold, Guenter (Emile Haefely and Co., Zurich). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 119-23 (June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Since the beginning of this decade the first high voltage electron microscopes designed as research facilities with energies from 0.5 to 1.5 MeV have come into operation. The electron beam is injected into the microscope columns from electron accelerators; this requires an extremely high stability of the accelerating voltage. Fully electronic ac supply and regulating systems have been developed in connection with the symmetrical cascade generator which approach an actual overall stability of one part per million with commercially available accelerators. Practical experience has proven, however, that ac interference between the high voltage generator and the accelerator will produce ripple voltages and noise that will neutralize the effect of the regulating and filter systems. To achieve an ultimate stability of 1×10^{-6}, or even higher for future applications, this problem has led to the design of the pressurized 1-MeV twin-tank accelerator with the high voltage generator and the accelerator located in separate vertical tanks. The units in the two tanks are interconnected by a high-ohmic damping resistor in a horizontal pressurized connection pipe. This system provides perfect electrical shielding and can easily be extended towards higher accelerating voltages. (auth)

27960 DESIGN EQUATIONS FOR DYNAMITRON TYPE POWER SUPPLIES IN THE MEGAVOLT RANGE. Thompson, C. C.; Cleland, M. R. (Radiation Dynamics, Inc., Westbury, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 124-9(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The power supply for the accelerating potential of the megavolt Dynamitron accelerators is a parallel-fed, series-cascaded rectifier system. Low-frequency rf voltage is capacitively coupled into the cascaded rectifier system by means of an SF-6 gas insulated electrode configuration. Maximum voltage attained with this configuration has been 5.0 MV. Maximum current attained has been 20 mA. Maximum beam power attained has been 40 kW. The development of equations which express the operational input parameters, such as oscillator plate voltage, current, and power in terms of the required output high voltage and load current, and the internal circuit parameters such as, tank capacitance, tank inductance resistance, number of rectifier stages, and oscillating frequency. Calculated data from these equations agree closely with experimental data. This analysis allows the optimization of a power supply design in terms of critical parameters for a given maximum output voltage and load current. (auth)

27961 PERFORMANCE AND MODIFICATIONS OF A 200-keV HEAVY ION ACCELERATOR FACILITY. Laubert, Roman; Robinson, Richard K. (New York Univ., N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 130-4(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The air insulated 200-keV heavy ion accelerator has been in operation for more than four years at our laboratory. Experience with this machine is reported and typical mass analysis spectra for various gases (O_2, Ne, CO, Ar, etc) are presented. The magnetic analyzing system has a stability of better than 0.01% without a feedback network. The four-ton analyzing magnets are mounted on pneumatic feet to allow positioning of the two magnets in any desirable configuration. The vacuum system that permits us to bombard targets without the buildup of a carbon layer is described. At the present time a program to double the machine energy is under way. This is accomplished by using a 400-keV 3-mA 0.1% regulation Cockcroft-Walton high voltage power supply built by Universal Voltronics Corp. Additional regulation (to 0.01%) is achieved by using a de-rippler circuit and feedback that utilizes sensing of the ion beam after mass analysis. (auth)

27962 THE INJECTOR COMPLEX FOR THE LAMPF ACCELERATOR. Allison, P. W.; Emigh, C. R.; Stevens, R. R. Jr. (Los Alamos Scientific Lab., N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 135-9(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The present planning and design goals for the injector complex include a high-intensity H^+ beam, an H^- beam, and polarized H^+ and H^- beams. Since simultaneous acceleration of H^+ and H^- beams will be attempted by the LAMPF accelerator, a dual beam transport system for blending these beams into a common channel will be necessary in the injector area. Provision also is made for injecting either H^+ or H^- polarized beams into the system. A high quality beam of protons (π cm-mrad emittance and 26 mA) has been produced by a Von Ardenne duoplasmatron and a Pierce extraction accelerating column. The problems of simultaneous bunching and beam matching of H^+ and H^- beams of different intensities have been studied. The entire injector complex is under computer control and should provide reasonably sophisticated pulse programming flexibility. (auth)

27963 A POLARIZED ION SOURCE FOR THE BERKELEY 88-INCH CYCLOTRON. Luccio, A.; Clark, D. J.; Elo, D.; Frazier, P.; Morris, D.; Renkas, M. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 140-4(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

A polarized proton and deuteron source has been built for the cyclotron. The source of the atomic beam type is of classical design, with a 50-cm sextupole and two rf adiabatic transitions. The atomic beam is ionized by electron impact and injected axially into the cyclotron. Design and performances of the source are described. (auth)

27964 PRODUCTION AND ACCELERATION OF DEUTERIUM AND HELIUM IONS. Passner, A.; Bertuccio, T.; Isaila, M.; Sober, D.; Vosburgh, K. (Princeton-Pennsylvania Accelerator, Princeton, N. J.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 145-7(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

In response to the growing interest in high energy D^+ and He^{++} ions, studies were made to determine the feasibility of accelerating these ions in the PPA. The studies indicated that to accelerate D^+ ions to 600 MeV, the rf would have to operate at the 12th harmonic; to produce 2.4-GeV D^+ ions, the rf would operate at the 8th harmonic. An attempt was successfully made to accelerate D^+ at the 12th harmonic; a beam of $\sim 6 \times 10^{11}$ D^+/sec was obtained at 600 MeV. An effort is now being made to accelerate D^+ on the 8th harmonic. In addition, an attempt is being made to obtain a useful beam of He^{++} ions. (auth)

27965 SOME RESULTS OF STUDIES OF PROTON BEAM PRODUCTION AND TRANSPORT FOR PLANIM. Walsh, T. R.; Carne, A.; Planner, C. W.; Ranft, J.; West, N. D.; Wroe, H. (Rutherford High Energy Lab., Chilton, Eng.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 148-9(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

PLANIM is a proposal to replace the 15-MeV Nimrod injector by the existing 50-MeV proton linear accelerator. It calls for a new pre-injector to provide 75 mA of protons, a new linac tank of 0.5–10 MeV and a 200-m beam line with achromatic benders and inflector. A number of design problems of the system are discussed. An alternative third-harmonic booster is briefly considered. (auth)

27966 POST ACCELERATION BEAM PULSE LENGTH CHOPPER. Averill, R. J.; Collins, T. L. (Harvard Univ., Cambridge, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 150-1(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The CEA 130-MeV linac has a pulse length of 2 μs, and the 6-GeV synchrotron accepts only a 0.7-μs pulse length. To try to inject the entire 2 μs pulse results in unnecessary radiation damage to vacuum chambers and various portions of the transport system. It is desirable to inject only a 0.7-μs pulse, and to select, empirically, that portion of the linac pulse that has the least energy spread. The unwanted portion of this pulse should be deposited on a suitably designed beam stopper. A system of bias magnets and a pulsed ferrite magnet followed by a water-cooled collimator has been installed and precisely chops the 130-MeV linac pulse. The injected pulse chosen has the smallest energy spread. The overall system has been designated PAC for post accelerator chopper. The PAC system, and our experience with it are described. (auth)

27967 OPERATION OF A 4-mA DYNAMITRON AS A MONOENERGETIC NEUTRON SOURCE. Haberl, A. W.; Taylor, A. (Cornell Univ., Ithaca, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 152-5(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The Cornell Dynamitron is being used as a source of monoenergetic neutrons in the 30–500 keV range, with fluxes up to 10^9 n/str-sec. Problems of generating and handling the 2-MeV, 4-mA are discussed, together with targets and projected performance for other energy ranges. Analyzing magnet slit feedback is essential for accurate control of neutron energy. Contrary to other published data for these machines, up to 3% drift in the energy was observed when it is controlled by the voltage feedback system. Discrepancies between this and previously published data are discussed. (auth)

27968 PERFORMANCE OF THE CORNELL 10-GeV ELECTRON SYNCHROTRON. Tigner, M. (Cornell Univ., Ithaca, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 156-8(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

A report on the characteristics of the Cornell machine during its first year of operation is given. Service record summaries are presented, and a description of major improvements made during the year is given. (auth)

27969 OPERATION AND PERFORMANCE OF THE UNIVERSITY OF WISCONSIN PHYSICAL SCIENCES LABORATORY ELECTRON STORAGE RING. Rowe, E. M.; Otte, R. A.; Pruett, C. H.; Steben, J. D. (Univ. of Wisconsin, Madison). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 159-64(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

A 240-MeV electron storage ring has been put into operation at the Physical Sciences Laboratory of the University of Wisconsin. The storage ring injector is a 50-MeV FFAG electron synchrotron. The bunched beam from the synchrotron is injected into the storage ring in a single turn. Radio-frequency capture may then be accomplished by one of three methods: adiabatic capture, injection into standing buckets, or by self-capture. The latter process involves using the signal from the bunched beam as the master oscillator during capture. After capture the beam may be held at any radius in the radial aperture of the ring, which is about 6 cm. The beam may be accelerated, or decelerated, to any energy within the capability of the ring— 10 MeV to 240 MeV. The vacuum system operates in the mid 10^{-10} range permitting life times of many hours for low intensity beams. During initial operation several interesting effects have been observed. Among these were photo etching of metal from the vacuum chamber by synchrotron radiation and enhanced beam loss due to scattering from ions trapped in the electron beam. These and other effects are discussed. (auth)

27970 ACCELERATOR DEVELOPMENT ACTIVITY OF THE RADIOTECHNICAL INSTITUTE. Mints, A. L. (Radiotechnical Inst., Moscow). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 165-9(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

27971 SOME ENGINEERING PROBLEMS ON SERPUKHOV ACCELERATOR. Komar, E. G. (Research Inst. of Electrophysical Equipment, Leningrad). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 661-6(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

27972 SIMULTANEOUS MULTIPLE TARGETING TECHNIQUES. Ratner, L. G. (Argonne National Lab., Ill.); Hornstra, F.; Marcowitz, S.; Romanowski, T.; Scherr, R. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 170-1 (June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

During 1968 two new internal targeting modes were successfully tried in the Zero Gradient Synchrotron. These modes will substantially increase the utilization of the ZGS by giving beam to several beam lines on the same machine pulse for the entire length of flat-top. The first of these modes, using two targets 180° apart, was tried in preparation for utilization of the second extracted proton beam area. Beam intensity could be arbitrarily divided on the two targets for the full 750-msec flat-top. Additionally, secondary particles from one of these targets can provide a pion beam into the meson area. Measurements of emittance showed no significant change from previous single-target extraction. The second mode utilized beam-sharing on two targets located about five feet apart in the magnetic field of the ZGS ring magnet. In this case, an extracted proton beam was delivered into area one; a neutron beam at 1° production angle and a pion beam were delivered into the meson area. It appears possible to combine these two modes and thus be able to provide a 750-msec spill into four different beam lines on each machine pulse. (auth)

27973 BEVATRON EXTERNAL PROTON BEAM FACILITIES. Elioff, T.; Force, R. J.; Hartsough, W. D.; Lou, K. H. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 172-3(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The first Bevatron external proton beam system became operational in 1963. The successful operation of this system together with the advantages of an external beam has resulted in heavy reliance on this facility by the experimental program. This warranted further development to increase the number and independence of target stations. The initial single channel system with series targeting at three foci operated from 1963 through 1967. In early 1968, a new system was installed in which the extracted beam was split into two channels, each having two target stations. This change, together with other improvements, more than doubled the experimental capability of the facility. As many as eight experiments now operate together utilizing the external beam under varied beam spill conditions. The operation of this system is described together with details of shielding, utilities, and physical facilities. In mid-1969, further improvements will be made. One of the present channels will be split via septum magnets to eliminate the limitations imposed by the intermediate focus in this channel. This will provide maximum flexibility at each target station. An additional station for direct experimental use of full energy protons will be provided. In addition all external beam magnets will be computer controlled. (auth)

27974 DESIGN AND CONSTRUCTION OF PHYSICAL FACILITIES, AGS CONVERSION PROJECT. Lancaster, J. H. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 174-5(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The $47,800,000 Alternating Gradient Synchrotron Conversion Project includes $17,500,000 for the design and construction of buildings, utilities, and structures. The design philosophy, basis of design, construction schedules, and construction costs are discussed and illustrated for the 200-MeV linac building, experimental building, increased radiation shielding, modifications to the existing magnet enclosure, special building to house the main magnet power generator and high level radiofrequency equipment, new experimental area, seven new and modified cooling water systems for machine and research use, and for utilities and site work. (auth)

27975 BEAM AMPLITUDE BEHAVIOR UPON CROSSING A LINEAR COUPLING RESONANCE WITH DAMPING IN ONE DIMENSION. Lee, M. J. (Brookhaven National Lab., Upton, N. Y.); Courant, E. D.; Pellegrini, C.; Sessler, A. M. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 176-9(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Single particle behavior, in the neighborhood of the coupling resonance $\nu_x + \nu_z = 1$, is studied in the presence of a damping term, proportional to $\dot{z}$, in the equation for $\dot{p}_z$. The equations of motion are transformed to phase-amplitude form. Numerical studies of amplitudes, as a function of rate of resonance crossing and amount of damping, will be presented. For sufficient damping, after passage through the resonance the vertical amplitude has hardly increased while the radial amplitude has grown significantly, which may explain observations, on the ZGS, of beam behavior in the presence of a damping electrode. More interestingly, the calculation suggests the possibility of generally controlling resonant beam growth by means of damping electrodes. (auth)

27976 EFFECT OF IONS ON THE SYMMETRICAL THROBBING BEAM MODE. Hereward, H. G.; Morton, P. L.; Schindl, K. H. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 180-1(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Previously, the quality of vacuum necessary in an accelerator was determined by the acceptable beam enlargement due to scattering on the residual gas. It has been demonstrated that the presence of ions produced by the beam can cause unstable transverse beam oscillation in a way similar (apart from a sign difference) to the effect of a vacuum chamber with finite conductivity. For some of these modes it is possible to design feedback systems to damp the unstable oscillations. However, the symmetrical throbbing mode, where the radius of the beam oscillates, produces rather little field outside the beam itself and would therefore be very difficult to stabilize by feedback. It may even be mistaken for an incoherent instability. Growth rates and stability criteria are determined and numerical examples presented. They demonstrate that the need to control this throbbing beam mode may determine the vacuum requirements for future accelerators. (auth)

27977 DAMPING BUNCH SHAPE OSCILLATIONS IN THE BROOKHAVEN AGS. Raka, E. C. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 182-6(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Bunch shape oscillations are present in the AGS, both before and after the transition energy (≈8 BeV) is reached. At transition, they can be excited by timing, phase and radial misadjustments, and beyond by rapid large radial position changes used for targeting or by rapid large (>20%) targeting losses. They can also be excited before transition by misadjusting the low level rf control system. In addition, excitation before transition can occur when $2f_s = 720 \sim$ the magnet ripple frequency or when $2f_s = 360 \sim$ the ripple frequency on the rf cavity tuning servo systems. An analysis of the rf phase control system including second order effects indicates that it should damp these oscillations but at a rate $\sim f_s/\beta\gamma$, except in the vicinity of transition. At 200 msec, $E \approx 6.5$ BeV, $\gamma \approx 6.9$, $f_s \approx 200 \sim$ and the damping rate is ≈ 0.46 sec^{-1}. Thus, adequate inherent damping is present only early in the acceleration cycle. This, plus the fact that the sensitivity of the phase control electronics to bunch shape variations can at times produce antidamping, has led to the design and testing of various feedback damping systems to control these oscillations. An analysis of rf phase and amplitude feedback, using a peak detected signal, as applied to the rf control system, is given. Operational results for both types of feedback are described. (auth)

27978 INVESTIGATION OF GRADIENT CORRECTIONS FOR THE AGS. Herrera, J. C.; Month, M. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 187-91(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

A non-superperiod symmetric gradient perturbation results in an instability in the vicinity of integer and half-integer ν values. By studying the integral form of the equation for the perturbed motion, conditions to any order in the perturbation are found such that the resulting particle motion at these critical ν values is periodic for arbitrary initial values of the coordinates of the particle trajectory. Such a periodicity implies stable motion in the region of these critical ν values. The nature of these corrected periodic orbits and the cumulative effects on the motion over many particle revolutions are investigated for the AGS. (auth)

27979 ORBITS AND NONLINEAR EFFECTS IN TERMS OF THE FIELD COEFFICIENTS IN THE MEDIAN PLANE. Chien, C. S. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 192-3(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

In the circular accelerators, the Lagrangian of motion can be derived by considering the azimuthal angle as the independent variable. The equilibrium orbits and betatron oscillations can be obtained in terms of the field coefficients in the median plane. The method has been applied to the fixed field alternating gradient synchrotrons. Here the general application to the circular accelerators will be discussed. In the same spirit, the nonlinear effects can also be studied in terms of these field coefficients. Since the sets of the field coefficients are different at lower and higher energies of the particles, it is possible to predict, at a particular energy, which nonlinear term is most dangerous. (auth)

27980 BEAM DYNAMICS IN LINEAR ACCELERATORS. Gluckstern, R. L. (Univ. of Massachusetts, Amherst). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 194-201 (June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The uncoupled equations of motion of charged particles in the longitudinal and transverse directions in a linear accelerator in the absence of space charge forces are reviewed. The effect of coupling on the dynamics is introduced and results are obtained for the apparent increase of the projected phase space areas. Questions of nonlinearities, misalignments, focusing field errors, and fringing field couplings are discussed. In the presence of space charge forces, oscillation frequencies are decreased, admittances are changed, and additional couplings and nonlinearities are introduced. These cause further deterioration in beam quality. An effort has been made to identify those particular effects that play the major role in increasing phase space areas. Comparisons are made with detailed three-dimensional orbit computations in an effort to sort out the various effects. (auth)

27981 NUMERICAL CALCULATIONS ON TRANSVERSE EMITTANCE GROWTH IN BRIGHT LINAC BEAMS. Chasman, R. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 202-6(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Previous six dimensional linac orbit calculations, performed with a computer program that was designed to include space charge forces, suggested that there is a considerable transverse emittance growth in beams with a brightness of 10^9 and higher. This appeared to be caused by non-linear space charge forces. Further calculations were aimed at giving a more specific explanation to results obtained earlier. The effects of transverse-transverse and transverse-longitudinal coupling through nonlinear space charge forces were separated and the dependence of transverse emittance growth on the initial particle distribution and on the magnitude of strong-focusing flutter are examined. (auth)

27982 SPACE-CHARGE FORCES IN A LINAC BUNCHER. Chidley, B. G.; Lee-Whiting, G. E. (Atomic Energy of Canada Ltd., Chalk River, Ont.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 207-9(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Three-dimensional calculations have been carried out with a continuous-fluid model. The beam is considered to be sliced into a number of equal disks and numerical integration is used to follow the motion of their centers. Particles are studied by expanding their coordinates with respect to the disk centers as a power series (truncated after third-order terms) in the initial values of the transverse coordinates. Equations of motion are derived for the expansion coefficients, and these are integrated simultaneously with the equations for the centers. Integrals representing space-charge forces, needed in the equations of motion, are evaluated after transformation to the space of the initial values of particle coordinates; this eliminates the need to calculate charge densities. The advantage of our method over one involving disks, MRA, or multiple particles is that the positions and weights of points used in the integrations for space are not fixed from the start of the calculation but are chosen anew for each step in such a way as to maximize efficiency. The accuracy obtained ought to be equivalent to that obtained by using very many more points in one of the other methods. (auth)

27983 MULTIGAP DEBUNCHERS. Benton, A. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron Eng.), Trans. Nucl. Sci., NS-16: 210-11(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The performance of two and three gap debunchers was investigated by computing how well a straight line between the ordinates +1 and −1 and of abscissa length π radians can be approximated by a two and three term harmonic series. What is desired is a series that will minimize the maximum deviations between the straight line and the series approximation to that line. The usual Fourier series, or least squares fit which is equivalent to it, does not satisfy this desideratum. The series coefficients were obtained by means of a computer program written for the CDC-6600. For a two term series, the minimized maximum difference is 0.017. A three term least squares fit gives a maximum difference of 0.0058; this is small enough for our purpose, so no calculations were done to minimize it. The calculations were repeated for a straight line of extension 4 radians along the abscissa. The results are minimized maximum differences of 0.064 and 0.014, for two and three term series respectively. (auth)

27984 PHASE STABILITY STUDIES FOR THE ING LINAC. Chapman, W. S. (Chalk River Nuclear Labs., Ont.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 212-13 (June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The ING linac was to have consisted of 9 Alvarez tanks operating at 268⅓ MHz, accelerating the beam from 0.75 MeV to 105 MeV, followed by 323 coupled cavity tanks at 805 MHz taking the beam to the full 1000 MeV. The tolerable beam spill level for the whole accelerator was about 1 part in 10^4 of the accelerated beam. The frequency transition at 105 MeV meant that, with moderate tolerances in the accelerating fields, loss from phase stability could contribute to beam spill at this level. A digital computer method was used to trace the beam through the linac in the presence of time varying errors in the accelerating fields. The field tolerances required to keep the loss from phase stability below the tolerable spill was calculated and an optimum law for the stable phase in the 805-MHz section was deduced. The tolerances have also been calculated for a control scheme in which the reference for the accelerating field phase is derived from the beam, rather than from a reference line as is usually the case. (auth)

27985 ANALYSIS OF TRAVELLING-WAVE PREBUNCHERS. Petersen, G. W.; Gallagher, W. J. (Applied Radiation Corp., Walnut Creek, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 214-15(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The use of single-gap cavity-type prebunchers to increase the capture fraction of the electron beam injected into a linac, as well as to improve the output energy spectrum, is well known. The use of a travelling-wave structure having a phase velocity corresponding to the gun voltage, as a bunching mechanism, is discussed. The analysis includes the effect of space charge forces on both radial and longitudinal focusing. Experimental results are presented for beam currents up to twenty amperes. (auth)

27986 TRANSVERSE SPACE-CHARGE EFFECTS IN BUNCHED BEAMS. Claus, J. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 216-20(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

It is noted that in general transverse space-charge effects will cause the emittance of a bunched beam moving in a transport system to become modulated with the bunch frequency, even if the emittance of the beam source is stationary in time. Long channels and high brightness tend to aggravate the effect. This cause of apparent and real blowup is treated analytically for periodic focusing systems conducting beams with small momentum spread. It was found that the blowup may be minimized by choosing a focusing system of sufficient strength and by matching the beam emittance to its characteristics. Applying the same methods to nominally achromatic dispersive systems, it was found that transverse space-charge effects prevent exact momentum recombination for bunched beams. (auth)

27987 DESIGN OF THE LOW ENERGY BEAM TRANSPORT SYSTEM OF THE BNL 200 MeV INJECTOR LINAC. Chasman, R.; Sluyters, T. J. M. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 221-6(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The distance between the 200-MeV linac and the 750-keV preinjector is designed to be about 27 feet. A 200-mA beam must be transported and bunched over this length without excessive loss in beam quality. To investigate the requirements of such a transport system numerical beam dynamics calculations, taking into account the effects of space charge, have been performed. Nonlinearities due to quadrupole fringing fields were also included in the computations. These have been shown earlier to have serious effects on the beam quality in a transport channel. In the present study an effort was made to minimize distortions introduced by fringing fields. This can be accomplished by a suitable choice of quadrupole system, as predicted analytically. Results obtained from calculations for different magnet schemes will be presented and the general layout of the transport system will be shown. (auth)

27988 PARTICLE TRAJECTORY PERTURBATIONS IN BEAM HANDLING SYSTEMS. Dobson, J. (Gulf General Atomics, Inc., San Diego, Calif.); Gallagher, W. J. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 227-31(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Three types of perturbations on particle trajectories in beam handling systems due to space charge forces are discussed assuming the beam to be bunched. 1) Owing to radial space charge forces, the beam will expand in diameter in field-free (or drift) spaces along the beam orbit. 2) Owing to longitudinal space charge forces, energy dispersion will increase along the beam trajectory. 3) Particle trajectories of the inner and outer edges of a monoenergetic beam crossing a magnetic field are not similar. As a result there appears to be an energy dispersion in the beam. Mathematical analyses of these space charge effects and numerical calculations of their magnitude in several existing high-current linacs are given. (auth)

27989 DESIGN AND EVALUATION OF PARTICLE BEAM HANDLING SYSTEMS. Galejs, Annija; Trent, Philip (High Voltage Engineering Corp., Burlington, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 232-3(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The procedures available, and in current use at HVE, for calculating beam-handling systems to various degrees of approximation and exactness are discussed. With a self-optimization feature built into the ion-optics programs a first-order design is obtained subject to the boundary conditions imposed by the available space, by the specified target locations, and by the aperture restrictions of the available components. The optimization is most commonly applied to obtain a minimum beam cross-over, focused at a given location. It is generally applicable, however, to any desired number and type of parameters. An example of particular importance is the minimization of the difference in flight time, including the effect of the momentum spread, during the design of isochronous systems for pulsed beam applications. Where it is desired or becomes necessary to evaluate the system quality in detail, the higher order effects are studied by exact ray tracing methods. From measured fringing fields, the aberrations are calculated in the individual components and the cumulative effect of these aberrations in a many-component system is derived. These techniques are illustrated by considering an example of a typical tandem post-acceleration beam handling system. (auth)

27990 INITIAL PERFORMANCE OF THE AGS SLOW EXTERNAL BEAM. Blumberg, L. N.; Barton, M. Q.; Bennett, G. W.; Fox, J. D.; Glen, J. W.; Hsieh, H. C. H.; Nawrocky, R. J.; Soukas, A. V. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 234-41 (June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Nonlinear resonance extraction at $\nu_x = 8\frac{2}{3}$ has been achieved in the energy range 20-28 GeV at calculated radial beam positions and settings of ejection magnets. Measured extraction efficiency of 70 to 80% is near the theoretical ~85%. Septum scattering results in horizontal and vertical emittances about 2.5 times larger than predicted. The method used to turn off the rf results in a 1% momentum spread which necessitates steering-magnet corrections in the external optics. Spill modulation from AGS magnet current ripple is controlled by feedback from spill monitors to the magnet voltage regulator and a signal from a backleg winding to an AGS quadrupole to modulate ν_x. Spill duration is ~400 msec (limited by septum heating). The beam is time-shared with internal targeting experiments by alternate pulse operation. (auth)

27991 EXTRACTION AND TRANSFER OF HIGH-QUALITY BEAMS FROM SYNCHROTRONS OF THE FOOFDOD TYPE, WITH APPLICATION TO THE OMNITRON. Meads, Philip F. Jr. (Brobeck and Associates, Berkeley); Selph, Frank B. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 242-5 (June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Acceleration of ions of low charge-to-mass ratio in the Omnitron is accomplished in two or three acceleration cycles with the beam transferred between the synchrotron and the concentric storage ring between cycles. Success in such multiple acceleration requires that the beam quality be maintained through each ring-to-ring transfer. The extraction method here described provides a perfect ring-to-ring match in both betatron phase planes, including dispersion. Maximum efficiency is obtained from the deflecting magnets as a consequence of both kicking and extracting at the point of maximum radial betatron amplitude. The beam path and focusing are chosen to minimize the aberrations due to passing through the extreme fringing fields of the gradient magnets. This requires a special focusing magnet in the accelerator extraction line and the shimming of two storage ring gradient magnets. (auth)

27992 TWO-TURN EXTRACTION FROM AN INJECTOR SYNCHROTRON. Van Steenbergen, A. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 246-54(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

For a fast cycling synchrotron injector (booster), a significant cost reduction, mainly related to rf requirements, may be obtained by reducing the booster cycling rate. For this reason slow cycling synchrotrons with multiturn extraction have been considered for the purpose of a booster injector. The disadvantage of time dependent beam emittance and beam intensity during the extraction process is well known. With two-turn extraction this problem can be avoided, making it still possible to reduce the booster cycling rate by a factor of two. Specifically for the 200-400 GeV NAL accelerator booster synchrotron, two-turn extraction has been studied and results are reported here, mainly related to extraction losses, betatron oscillation tune tolerance, and extracted beam effective phase space dilution or beam transfer losses. (auth)

27993 THE EFFECT OF MOMENTUM SPREAD IN SLOW EXTRACTION AT AN INTEGER RESONANCE: A THEORETICAL STUDY. Strolin, P.; Wilson, E. J. N. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 255-9(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The behavior of a beam with momentum spread undergoing extraction at an integer resonance has been studied with a simple analytic model and a more comprehensive computer program. It is shown that the stable and unstable fixed points can have an amplitude of oscillation about the unperturbed closed orbit that is comparable with the available radial aperture. This could lead to loss of the lower momenta before extraction spill takes place and to a lower extraction efficiency than that given by simple theory. These effects are discussed with particular reference to the CERN PS Slow Extraction. (auth)

27994 A SLOW EXTERNAL BEAM FOR THE CORNELL 2-GeV ELECTRON SYNCHROTRON. Browman, A.; Hand, Louis N.; Rouse, G.; Tso, T. (Cornell Univ., Ithaca, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 260-1 (June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Beam extraction has been achieved at the Cornell 2-GeV electron synchrotron by using independently controlled quadrupole and octupole magnets inserted in a straight section. The actual extraction is made with a pulsed septum magnet which avoids the problem of aberrations due to the synchrotron fringe field. Extraction takes place on 3.5 integral resonance in horizontal betatron oscillations. The octupole field provides the non-linearity essential to efficient extraction. Characteristics of the beam are given. (auth)

27995 DESIGN OF THE 200-GeV SLOW EXTRACTED BEAM AT NAL. Andrews, R.; Maschke, A.; Mobley, R.; Rode, C. (National Accelerator Lab., Batavia, Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 262-5(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The design criteria for the slow beam are given, and the methods for achieving high-extraction efficiency are discussed. (auth)

27996 ENERGY-LOSS EXTRACTION SYSTEM WITH THIN-SEPTUM PLUNGED MAGNET AT NIMROD. Armstrong, A. G. A. M.; O'Connell, M. J.; Edwards, V. W.; Morgan, R. H. C.; Sheehan, M. J. (Rutherford High Energy Lab., Chilton, Eng.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 266-70(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Details are given of a system involving an energy-loss target, a plunged 1.0-cm septum magnet and correction of the Nimrod field where the beam emerges. A stationary radially focusing element is proposed, placed in the exit path of the beam, at a point soon after the beam has left the Nimrod magnet. This element consists of a magnetic channel energised partially from Nimrod fringe flux and partially from powered windings. The applied current has to be programmed with the magnet pulse to minimize disturbance of the accelerator field. Design work has so far been done with the program TRIM, solving the sections of the configuration in various azimuths as two dimensional problems. The lip and targeting program LIMP have been used to generate realistic assemblies of, typically, 100 particles, which are then tracked through the extraction system using the program NIMDYN, which uses a detailed field model of the accelerator. A tagging facility enables particle identity to be retained through to the final statistics on assemblies of 100 particles or less. (auth)

27997 LATTICE OF THE NAL PROTON SYNCHROTRON. Garren, A. A. (National Accelerator Lab., Batavia, Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 271-6(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

A brief description of the design adopted for the lattice of the 200-GeV accelerator to be constructed in Illinois is presented. The main features of this design are the following: capacity for acceleration to 200 GeV at 9 kG or 400 GeV at 18 kG; separated-function FODO standard cells; inclusion of six 50-meter-long straight sections; and relatively small circumferences. Other designs studied were combined function FOFOOD, and separated-function lattices with the quadrupoles grouped in doublets or triplets. (auth)

27998 LENSES FOR HIGH ENERGY ELECTRON BEAMS. Gallagher, W. J. (Applied Radiation Corp., Walnut Creek, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 277-8(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Use of the Glaser lens for axisymmetric focusing of electron beams is described, using a boundary value solution for the lens field and relativistic equations of motion. By this method lens aberrations appear as successive terms of the field solution. The effect of space charge forces on lens performance is discussed. Among electron microscopists it is well-known that a requirement for constructing an ideal lense is that the axial field intensity diminish radially. This condition, of course, cannot be met for a static field unless the field boundaries are superconducting. However, time varying fields possess this characteristic, and a cavity supporting the TE-01 mode is proposed as microwave lens, useful where beams have an rf microstructure. (auth)

27999 THE APPLICATION OF TRANSIENT BEAM LOADING IN LINEAR ACCELERATORS TO OBTAIN A FIXED CHARGE/PULSE. Dobson, J.; Williams, C. B. (Gulf General Atomic Inc., San Diego, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 279-80(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

A technique is proposed as a fail-safe method of limiting the current in the electron mode of operation of medical linear accelerators. In the initial stage of transient beam loading of an electron linear accelerator, the decrease in energy with time is about linear. It is shown that this phenomenon can be used to obtain a constant charge per pulse independent of accelerated beam current and peak beam energy when the accelerator is used in conjunction with an energy analyzing system and defining slits. The energy and the charge per pulse of the beam passing through the slits are independent of the accelerated current and peak beam energy, provided the slit energy bin lies on the linear part of the transient loading curve. Charge per pulse passing through the slits is directly proportional to slit width. The limitations of this technique and its application to various fields, including the electron beam therapy of malignant tumors and pulse radiolysis, are discussed. (auth)

28000 PROTON BEAM COOLING WITH ELECTRONS IN THE NONRELATIVISTIC CASE. Maurer, W. (Kernforschungszentrum, Karlsruhe, Ger.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 281-5(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The mechanism of collision damping for heavy particles is investigated in the nonrelativistic case. By means of the FOKKER-PLANCK coefficients the mean rates of change of momentum and energy for two kinds of particles and energy and temperature relaxation times are calculated. The energy changes in the various directions have been evaluated. It is possible to give a condition for beam cooling in the transversal directions. As an example, we have given the results for a proton-electron system. Calculations for relativistic particle energies are in progress. (auth)

28001 MULTISHOT AND MULTICHANNEL FAST EJECTION. Bossart, R.; van Breugel, H.; Caris, L.; Dijkhuizen, H.; Kamber, I.; Kuiper, B.; Leroux, J.; Milner, S.; Nicolai, B.; Williams, E. M. (European Organization for Nuclear Research, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 286-90(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

A new fast beam extraction facility has been installed in the CERN proton synchrotron. The system provides, during the same machine cycle, up to three partial fast ejections to the same or different experimental areas at minimum intervals of 150 to 200 ms. The number of proton bunches at each ejection may be varied continuously, and furthermore the system may be programmed to perform different ejection schedules from machine cycle to machine cycle. (auth)

28002 EXPERIMENTAL INVESTIGATION OF THE INFLUENCE OF QUANTUM FLUCTUATIONS OF RADIATION ON THE MOTION OF ELECTRONS IN THE 1.5-GeV SYNCHROTRON AT TOMSK POLYTECHNICAL INSTITUTE. Vorobev, A. A.; Didenko, A. N.; Kozhevnikov, A. V. (Tomsk Polytechnical Inst., USSR). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 291-3(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The influence of synchrotron radiation on synchrotron and betatron oscillations was measured separately on the 1.5-GeV electron synchrotron at the Tomsk Polytechnical Institute. The separate investigation of betatron and synchrotron oscillations was made possible by the joint use of the image tube with the cycle scanning of the image and speed filming. The image tube, working under the operating conditions of an image-converter chronograph allowed the determination of the amplitude of phase oscillations. From the ratio between the change of phase and radial bias of electrons the link between the amplitudes of phase and radial-phase oscillations was also determined. From the simultaneous measurement of the cross-section of the electron beam by speed filming it was possible to determine which part of the common radial size of the electron beam is explained by the radial betatron oscillation and which by radial-phase oscillations. The optical circuit of the device was used for investigating the quantum excitation of electrons. The amplitude of electron oscillations was measured by the method described by F. A. Korolev, et al. (J. Phys. of USSR 134, 314(1960)). Results of these measurements and comparison with previous measurements are presented. (B.G.D.)

28003 ASTRON LINEAR ACCELERATOR. Beal, Jack W. (Univ. of California, Livermore). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 294-8(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The Astron induction, electron accelerator has been redesigned and rebuilt to increase the beam energy and output current and to improve the quality and reliability of the output beam. The design beam parameters are: energy −4.2 MeV, current −800 A, pulse width −0.3 μsec; momentum spread −4% FWHM, emittance −25π mr-cm. The accelerator consists of an increasing-gradient gun with an oxide cathode and an output beam energy of 562 keV. The gun is followed by two constant-gradient injector sections, each adding 220 keV to the beam energy. The remainder of the accelerator is made up of seventeen identical accelerator sections, each adding 190 keV to the beam energy. Solenoidal magnets are positioned between the accelerator sections to provide for beam focusing. Cosine-type steering magnets are placed so as to compensate for the earth ambient magnetic field and possible strong fields. Initial operating experience with the new accelerator is described and results are presented. (auth)

28004 FIRST OPERATION OF THE HIGH DUTY CYCLE SACLAY ELECTRON LINAC (A.L.S.). Azam, G. (Compagnie Generale de Telegraphie Sans Fil, Corbeville, France); Leboutet, H.; Netter, F.; Tzara, C. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 299-303(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Tests in CFS laboratories have given evidence for the excellent quality of the bunching in the first section. Tests on the site starting in January 1968 were performed during all the year. Operations with both electron and positron beams give many results, namely maximum electron energy 640 MeV with zero current and 540 MeV with 40-mA peak current and an energy distribution with FWHM 3 to 4/1000. The maximum peak current obtained was 60 mA; no beam break-up appears. Operations were performed at duty cycles of 1% and 2% with electron beam power of the order of 100 kW during many shifts of 30 hours; energy stability was better than 1% for 30 hours. Special devices helping to handle the beam inside and outside the linac at such a power level are described. First measurements of e^+/e^- conversion efficiency give an intensity ratio of positron beam relative to electron beam, above 400 MeV positron energy, of the order of 5.10^{-4}; improvements are expected. (auth)

28005 DYNAMICS OF THE BEAM OF ELECTRONS IN THE A.L.S. Azam, G.; Bensussan, A.; Leboutet, H.; Roux, G. (Compagnie Generale de Telegraphie Sans Fil, Corbeville, France). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 304-6(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The excellent quality of the bunching of the Saclay accelerator was indispensable in obtaining the expected performances. A low voltage injection was chosen, solution already selected by CFS for its previous constructions. Bunching is obtained by bunching cavity and a beam chopper between the gun and the cavity. The results obtained conform to those given by the program established by the computer. As regards the phenomena known as B.B.U., the A.L.S. sections were already in construction at the time when worldwide reports were being made about it. The first known results, extrapolated for the A.L.S., would have given a peak current lower than 10 mA at 10 μs, at its maximal limit, i.e., five times less than was required. The group velocity distribution of the sections was redesigned. Three types of sections were calculated in order to eliminate recurrence, by alternating sections of these three types along the machine. The results of the tests showed that this method was successful. (auth)

28006 CONVERTER AND POSITRON ACCELERATION ON THE A.L.S. Aucouturier, J.; Leboutet, H.; Azam, G.; Perraudin, C. (Compagnie Generale de Telegraphie Sans Fil, Corbeville, France). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 307-8(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Estimated performances are as follows: Positron beam: 500 MeV with peak current of 60 μA, i.e., an average value of 0.6 μA. These performances take a principal electron beam of 30 kW on the converter target. The design of this target involves a water-cooled moving part in vacuum, immersed in the magnetic field of the converter. The complete system is described in this report. A report on the converter optic has already been published. The main results of the analysis of this publication are outlined here. An efficiency between positron and electron beam higher than 10^{-3} was expected. The first results obtained on the accelerator were (in September 1968): 5.10^{-4}, i.e.,.very near the expected figure. More experiments are to be made before the end of this year. (auth)

28007 THE 95-MeV ELECTRON LINAC AT AMSTERDAM. Bruinsma, P. J. T.; de Vries, C. (Inst. for Nuclear Research, Amsterdam). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 309-10(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The Institute's 95-MeV electron linac (EVA), now fully operational, will be described. At high energies and low currents 80% of the current of the low-emittance beam falls within a 0.3% energy-band. Maximum peak currents of up to 150 mA are obtained within a 0.8% energy-band. This performance is attained with two SLAC sections (each 3-m long), and a Frascati-type injector. The inherent properties of both are matched by the excellent performance of the peripheral equipment which includes two modulators for powering the two SLAC-type klystrons, the cooling system, the microwave driver, and interface instrumentation. (auth)

28008 RECENT BEAM PERFORMANCE AND DEVELOPMENTS AT SLAC. Helm, R. H.; Hogg, H. A.; Koontz, R. F.; Loew, G. A.; Miller, R. H.; Neal, R. B. (Stanford Linear Accelerator Center, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 311-15(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Recent developments at SLAC which have contributed to improvements in beam operation are described. The overall beam performance and operational efficiency in delivering beams to various experiments are examined. The specific developments, such as the achievement of higher energies, increasingly narrow energy spectra, higher beam breakup current thresholds, chopped beams, and improvements in pulse-to-pulse operation are discussed. The discussion includes a description of various new pulsed devices such as pulsed quadrupole, improvements in the positron source, and new beam-loading measurements obtained for very short pulses. (auth)

28009 PERFORMANCE OF 140-MeV HIGH CURRENT SHORT PULSE LINAC AT ORNL. Pering, N. (Varian Associates, Palo Alto, Calif.); Lewis, T. A. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 316-20(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

High current results exceeding specifications of 140-MeV electron traveling-wave L-band linear accelerator are discussed. The 150-kV gridded gun injector has demonstrated pulse currents in excess of 30 A and pulse widths as narrow as 2.3 nsec at 1000 pps. The accelerator wave guide sections are of nonuniform impedance design, 4.3 meters each and are driven by 24-MW 67.5-kW L-band klystrons. Uniform solenoidal focusing is used over the accelerating sections and quadrupole focusing is used in beam transport. A short pulse current exceeding 16 A has been observed at the target position within an area of less than 4 cm^2. (auth)

28010 STANDING WAVE OPERATION OF ELECTRON LINEAR ACCELERATORS. Gallagher, W. J. (Applied Radiation Corp., Walnut Creek, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 321-2(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Although periodic structures, when used as particle accelerators, always involve a particle-wave interaction that can be analyzed as a traveling-wave interaction (TW), the actual mode of operation may be standing wave (SW). In fact, most low energy accelerators are operated in this manner. Presentation of the analysis of SW operation is complicated because cryogenic (that is, superconducting with complete neglect of waveguide losses) or ambient operation produces quite different results; furthermore, the location of power input feedpoints varies details. This report discusses ambient temperature SW operation. Results of the analysis of cryogenic operation are quoted for comparison. (auth)

28011 VELOCITY MODULATION SYSTEM FOR ENHANCEMENT OF 50 PICOSECOND RADIATION PULSE. Norris, N. J.;

Hanst, R. K. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 323-8(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Intense radiation pulses, 50 picoseconds in duration with peak intensity of 30 amperes have been attained at the EG&G/AEC Linear Accelerator. Individual micro-structure groups of electrons that normally occur at the fundamental accelerating frequency have been isolated, as reported previously. Increased intensity of these 50-ps radiation bursts is attained through the use of velocity-modulation bunching at the sixth subharmonic of the acceleration frequency. The calculated and experimental charge increase is compared and the system is described in detail. The charge has been measured as 1.5 nanocoulombs per burst, about 30A peak for the 50-ps duration. Synchronization of the injector pulse to the rf acceleration frequency with a precision of 30 ps results in pulse to pulse reproducibility of a few percent and permits recurring pulse measurements to be made with sampling oscilloscopes. This short radiation burst, with increased intensity, allows the stimulation of scintillators and chemical systems to study their response in the subnanosecond time domain. Neutron time-of-flight measurements with a total resolution of 400-500 ps have also been demonstrated. (auth)

28012 RESONANTLY COUPLED STANDING-WAVE ACCELERATOR STRUCTURES FOR ELECTRON AND PROTON LINAC APPLICATIONS. Knapp, E. A. (Los Alamos Scientific Lab., N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 329-37(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Theoretical and experimental studies on resonantly coupled accelerator structures for both proton linac and electron linac use are reviewed. The side-coupled linac structure, useful both for electron linac and high energy proton linac systems, is described. The performance of a 25-MeV, 1-mA average, 6% duty factor side-coupled electron linac at the Los Alamos Scientific Laboratory will be discussed. The post-coupled drift tube linac structure, developed at Los Alamos, and the multistem drift tube linac structure, developed at Brookhaven, are discussed as examples of resonantly coupled low energy proton accelerator structures. (auth)

28013 SOME PRELIMINARY OBSERVATIONS ON A FAMILY OF LINAC MODES. Swenson, D. A.; Knapp, E. A.; Swain, G. R. (Los Alamos Scientific Lab., N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 338-9(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Chains of coupled resonators that support excitations that are periodic with the period of N $(O \le N \le \alpha)$ resonators were examined. The properties of these structures were studied for two cases: (1) the lossless case (with no net power flow) and (2) the lossless case (which is required to propagate power). (B.G.D.)

28014 A METHOD FOR CALCULATING RESONANT FREQUENCIES, MODE STRUCTURES, AND FIELD FLATNESS IN AN ALVAREZ TYPE LINAC CAVITY. Lee, M. J. (Brookhaven National Lab., Upton, N. Y.); Chasman, R.; Peterson, R. K.; Gluckstern, R. L. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 340-4(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Numerical calculations have been carried out to determine the effects of the non-uniformity of an Alvarez type drift tube linac cavity on the mode frequencies and average field flatness. This was done by following a method first used by Walkinshaw et al. for a single-cell cavity and recently extended by Gluckstern to multicell cavities. The object of the study is to obtain the following information: 1) mode structure and resonant frequencies of a cavity consisting of several identical cells, 2) mode structure of a cavity consisting of several cells with slowly varying geometrical parameters, 3) sensitivity of the field flatness to dimensional errors for the zero and $\pi/2$ modes. Results are presented and discussed. (auth)

28015 PROGRESS IN PROTON LINEAR ACCELERATORS. Wheeler, G. W. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 345-50(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

A new generation of proton linear accelerators is under construction. The new or improved techniques which will lead to major advances in the performance of these linacs are discussed. These include brighter ion sources and columns, cavity field stabilization techniques, beam loading and space charge compensation. The status of some of these new linacs is briefly presented. (auth)

28016 THE PROTOTYPE RF SYSTEM FOR THE 200-MeV LINAC INJECTOR FOR THE AGS. Keane, J.; Lankshear, R. F.; Sheehan, J. F.; Witkover, R. L. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 351-5(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The new 200-MeV Linac Injector being built for the AGS conversion program will be powered by nine rf modules with a total rf power output of over 40 megawatts. A prototype rf system has been built and operated for more than a year. The design features of the rf system include: modular construction for rapid replacement of defective units, solid state logic and control systems, a series passing tube used as a programmable capacitor bank charging and isolating element, and a floating-deck modulator using three magnetically focused triodes as the passing tubes and allowing linear control of the plate voltage of the 7835 triode final power amplifier. Grid drive for the 7835 is provided by a 350-kW driver unit, which also serves as the summing point for an rf phase control loop. Final design units are being procured. The design features and operating experience with the prototype system are discussed. (auth)

28017 BEAM EMITTANCE-TIME VARIATION OF THE 50-MeV PROTON LINEAR ACCELERATOR OF THE ZERO GRADIENT SYNCHROTRON. Abdelaziz, Mohamed E. (Atomic Energy Establishment, Cairo). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 356-8(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

One of the main problems considered in beam diagnostics of the 50-MeV proton linac of the Argonne ZGS was the measurement of the injected-beam emittance and density distribution in phase space. By scanning the beam with a fast strip electrode-and-slit combination with an angular resolution of 0.35 mrad it was possible to watch time variations of beam emittance during the linac pulse. Use was made of a multiplexed A-D converter and a high speed buffering system linked to a control computer, thus sampling the beam 200 times during the beam pulse at a speed of 1 μs per sample. Emittance figures were obtained and analyzed under different operating conditions of beam current, preinjector voltage, and quadrupole magnet current. These results are useful for future automatic computer-control of the linac beam during machine operation to satisfy optimum working conditions of the ZGS injector. (auth)

28018 A UNIQUE HIGH DUTY FACTOR SERIES HARD-TUBE MODULATOR FOR USE IN THE LOS ALAMOS MESON PHYSICS FACILITY. Faulkner, J. Ross (Los Alamos Scientific Lab., N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 359-61(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The 200-MHz portion of the Los Alamos Meson Physics Facility (LAMPF) requires three pulsed rf power sources, each delivering 3-MW peak power at 14.4% duty factor (120-Hz, 1200-μsec pulse). This rf energy must be controlled over a dynamic range of about 30% at a field amplitude tolerance of ±1.5%. The control of this rf power will be accomplished via a series hard-tube modulator. A modulator utilizing a pair of Eimac 4CW250,000A tetrodes in a rather unique screen-driven circuit has been constructed and tested at duty factors exceeding the required 14.4%. Plate voltages of up to 40 kV have been switched into a short circuit without losing control of the modulator. Amplitude modulation of the pulse using both a step function and a sinusoid has been successful. The problems of modulator tube voltage hold-off and grid emission which led to the design of this unique circuit are discussed. (auth)

28019 THE BNL 50-MeV LINAC RF MULTIPORT SYSTEM. Keane, J. T.; DeVito, B.; McNerney, A. J. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 362-6(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

A new high power rf system has been installed at the BNL 50-MeV linac to accelerate the higher beam intensities obtained from an improved preinjector. A 75-mA, 80-μs linac output current pulse with a good energy spread is the design goal. Design considerations for this system for coupling power to the linac cavity via three ports are discussed. System layout and mechanical design features that provide flexibility in system operation and tuning are presented. Initial operating experience and results obtained to date are also discussed. (auth)

28020 MICROWAVE INSTRUMENTATION FOR ACCELERATOR RF SYSTEMS. Jameson, R. A.; Hoffert, W. J.; Morris, D. I. (Los Alamos Scientific Lab., N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 367-71(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

In order to make detailed measurements of the rf amplifier-accelerator systems for the Los Alamos Meson Physics Facility (LAMPF) proton accelerator, it was necessary to develop better directional couplers and slotted lines. The degree of precision required in the construction and adjustment of these devices when measurements of a few percent accuracy are desired in complicated, mismatched, high-power systems is surprising. The theoretical considerations and the mechanical refinements necessary to achieve good performance are outlined in this paper. The results of some recent measurements on the rf system are reviewed. (auth)

28021 STUDY ON INTERDIGITAL H-TYPE STRUCTURE FOR HEAVY-ION LINEAR ACCELERATORS. Bres, M.; Chabert, A.; Gavet, J. C.; Tran, D. T.; Veyron, B.; Voisin, G. (Univ., Lyon). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 372-6(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Due to the very low heavy-ion velocity at injection, the frequency must also be kept low and the Alvarez and twin-line structures become inefficient. Experimental work has been done at Lyon on new type structures well suited for low velocity range, namely the interdigital H-type structure. The dimensions of this type of structure as well as its electrical characteristics prove to be very attractive at low frequency; furthermore, due to the particular field pattern in these resonators, radial focusing of the beam appears to be possible with magnetic quadrupoles at energy as low as 50 to 60 keV/nucleon and frequency in the range of 20 to 30 MHz. Such a field pattern also gives good acceptance for the whole cavity. This paper presents our last results, discusses various problems, and gives the main parameters of Lyon's 10 MeV/nucleon heavy-ion linear accelerator project. (auth)

28022 STRUCTURE FOR HEAVY ION LINACS. Pottier, J. (CEN, Saclay, France). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 377-9(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

This structure uses an essentially T.E. field instead of a T.M. one like in an Alvarez linear accelerator. The drift tubes are alternately connected to conducting plates fastened to the wave guide, so that the device operates on a π mode. The shunt impedance is roughly proportional to β^{-2}, so that this structure is convenient for injectors or heavy-ion accelerators. This shunt impedance is much higher than for an Alvarez structure for energies lower than about 20 MeV/nucleon in the case of a small diameter of drift tubes (grid focusing), and lower than a few MeV/nucleons in the case of larger diameters (strong focusing). The wavelengths to be used are about five times greater than in an Alvarez, so that the defocusing forces are about one fifth, and focusing is easier. For a given acceleration, such a machine, using a π mode, can be about one half the length of an Alvarez. A model accelerating deuterons from 50 keV to 350 keV has been built and operates properly. (auth)

28023 TRANSIT TIME FACTORS AND FIELD MAGNIFICATION FACTORS IN ION LINAC GAPS. Boehne, D. O. (Univ., Heidelberg). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 380-4(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Field measurements in gaps of different widths have been performed in the electrolytic tank and in a magnetic gap model. From these data the transit time factors and field magnification factors are derived and compared to existing information obtained by MESSYMESH field calculations and analytical approximations. (auth)

28024 RF SYSTEM DEVELOPMENT FOR THE HEAVY ION LINAC. Stadler, B. (Univ., Heidelberg). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 385-9(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The layout of the new radio frequency system for a variable-energy variable-mass heavy ion linear accelerator is described. Results from specially designed VHF amplifiers for variable power output as well as for the phase and amplitude control system are shown. (auth)

28025 LINAC CAVITY TECHNOLOGY. Boehne, D. (Univ., Heidelberg). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 390-4(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Both rf and outgasing properties of model cavities are reported. Electroformed, vacuum-cast, and ordinary copper sheet metal are compared with different electroplated mild steel samples. For the electroformed and electroplated full scale cavities the mechanical design is described. Results on vacuum pump down, metal gasket application, and performance of drive loops and tuning slugs are presented. (auth)

28026 INEXPENSIVE METHOD OF COOLING AN RF CAVITY. Main, R.; Haughian, J. M. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 395-6(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

A cylindrical rf cavity is cooled by water circulated through extruded cooling tubes fastened to the outside wall. During installation, these tubes are heated and clamped tightly in place. The details of the tube's cross section and spacing are discussed. A method of elongation and clamping, end connections, and conducting filler between it and the tank's wall are also discussed. (auth)

28027 GENERAL DESIGN FEATURES OF THE INDIANA UNIVERSITY 200-MeV CYCLOTRON. Rickey, M. E.; Sampson, M. B.; Bardin, B. M. (Indiana Univ., Bloomington). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 397-404(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

A multiple-stage four-sector separated magnet isochronous cyclotron is presently under construction at Indiana University. Ions are to be accelerated by potential drop before injection into the cyclotron stages permitting operation with $1 < \nu_z < 1.5$. The large flutter required for this axial strength increases the non-relativistic radial focusing frequency so that $\nu_r > 1.1$. The $\nu_r = {}^4/_3$ intrinsic radial quadratic resonance is encountered at $\beta = 0.43$ (100 MeV protons, 300 MeV ^{3}He) but extensive studies indicate that beam deterioration and loss are negligible with the chosen operating parameters. Fourth and higher harmonics of the orbital frequency are to be used for acceleration. A charge-to-mass ratio range of ${}^1/_6 \leq q/M \leq 1$ is planned; this, together with the external ion source, median plane injection, strong focusing and large dimensions, provides an excellent heavy ion capability. A maximum design energy of 200 MeV is planned for protons; maximum energies for other ions are given by $E = 240\ q^2/M$ MeV. A dee-in-valley design with the very large axial aperture inherent in this facility has many advantages. Among these are the narrow magnet gap, capacitive tuning of the dees, dee voltage increasing with radius, and structural simplifications. It also permits sufficient additional vertical aperture inside the dees for second harmonic rf electrodes permitting asymmetrical square-waving of the energy gain per turn versus rf phase. Use of the fundamental and second harmonics of proper relative amplitudes and phases can provide a uniformity 2 : 1000 over a 50° phase interval and 1 : 10000 over a 25° interval. A small additional third harmonic component can double these intervals. (auth)

28028 SYNCHROCYCLOTRON IMPROVEMENT PROGRAMS. Blosser, Henry G. (Michigan State Univ., East Lansing). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 405-14 (June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Increasingly the significant experiments in the energy range of the synchrocyclotron demand higher intensity and duty cycle. Mindful of this, and of the approaching operational status of high intensity facilities at Los Alamos and Zurich, the several laboratories with plans for continuing synchrocyclotron programs have in progress or under study improvement programs for increasing the intensity and duty cycle of their accelerators. The principal revisions contemplated include: (a) new rf systems to provide higher dee voltage and increased cycling rate, with details carefully matched to requirements for maximizing the accelerated particle flux, (b) new central region designs utilizing hooded arc sources and electric and magnetic fields shaped for maximum focusing, (c) spiral ridge magnet pole tips to reduce the range of frequency modulation and strengthen focusing, and (d) redesigned extraction systems which in combination with the improved emittance characteristics of the new central region will lead to much higher extraction efficiencies than in the past. The principal features of these revisions are reviewed with comments on the particular configurations contemplated by several typical major laboratories. (auth)

28029 MAGNETIC FIELD TOLERANCES FOR THE TRIUMF 500-MeV H$^-$ CYCLOTRON. Craddock, M. K.; Richardson, J. Reginald (Univ. of British Columbia, Vancouver). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 415-20(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The mass of steel in the TRIUMF magnet will be in excess of 3000 tons. In designing this magnet it has been found that there is considerable interplay between manufacturing methods and their tolerances on the one hand, and the tolerances required by beam dynamics on the other. Probably the most significant tolerance in its effect on manufacturing methods is that relating to the spiral shape of the magnet sectors. The precision required in this case will necessitate an extensive shimming program on the steel shape subsequent to manufacture. The need for axial focusing also sets limits on the variation in magnetic flutter and will have an important effect on the extent of the program to measure the magnetic field. The accuracy required for the measurement and rectification of the radial field gradient is determined by the requirement of isochronism, as is the number and arrangement of trim coils. Since the magnet is essentially composed of six separate sectors, the avoidance of a first harmonic sets some unusual limits on the positioning and uniformity of the sectors. The requirements of separated-turn acceleration are also considered. (auth)

28030 NEVIS SYNCHROCYCLOTRON CONVERSION PROJECT. Cohen, R. (Columbia Univ., New York); Martin, E.; Rainwater, J.; Schneider, R.; Ziegler, K.; Ohnuma, S. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 421-5 (June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The Nevis Synchrocyclotron is to be converted from a 390-MeV machine with an internal beam current of 1.6 μA and no external beam to one whose energy will be ~550 MeV. The internal beam current will be more than 20 μA and the external more than 5 μA. The average magnetic field will rise with radius—17.2 kG at the center to a maximum near 20 kG at 80 inches—to reduce the rf frequency swing and to increase maximum (BR) for a given yoke flux. The beam will be focused by a set of 3-fold spiral iron shims having a median plane gap of 1 inch near the center of the machine and 5 to 6 inches at the largest radii. Because of the small central median plane gap, one set of shims will be at the rf potential and will have to be supported on insulators. Using measured fields of model magnets in computer codes, it is found that the beam is vertically well focused at all radii. In particular, at the critical region near 10 cm where the effect of space charge is most serious, values of $\nu_z > 0.3$ have been achieved. (auth)

28031 AXIAL ELECTRIC FOCUSING IN A CYCLOTRON. Cohen, R.; Rainwater, J. (Columbia Univ., New York). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 426-9(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Usual calculations of the vertical focusing due to the dee voltage at small orbit radii involve approximations that are poorest for the first few turns where this electric focusing term is most important to compensate for the weak magnetic contribution. Two symmetric dees are considered and an infinite trajectory perpendicular to the dee mouth is treated, to obtain the net vertical impulse. The impulse for each half gap is treated separately, so that alternate gradient terms are not automatically averaged to zero. In a second independent method, a uniform vertical magnetic field was included, and both electric and magnetic forces were treated with a numerical integration of the equations of motion for a half turn. The proton momentum is initially parallel to the gap and to the median plane, with initial Z = 0.4 times the full dee height, and (simulated) space charge repulsion force proportional to Z is added. This yields the effective contribution to ν_z^2 to oppose vertical space charge repulsion when space charge and focusing terms cancel in their effect on P_z over a half turn. (auth)

28032 NEVIS SYNCHROCYCLOTRON CONVERSION PROGRAM: RF SYSTEM. Schneider, R.; Rainwater, J. (Columbia Univ., New York). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 430-3(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The proposed three-fold symmetric and radially increasing magnetic field requires the accelerating rf field to cover the frequency band from about 27 MHz to 18 MHz. The peak dee voltage will be between 30 and 50 kV, with the maximum near injection. The repetition rate will be ≥300 per second, with the rf turned on for 40% of the time. The (single) dee structure will be 170 inches wide and between one-quarter and one-half a wavelength long. One of the three pairs of sector-iron shims will be incorporated in the dee and supported on BeO insulators. For the presently favored design, tuning will be accomplished by two rotating capacitors with axes directed toward the center of the magnet. Each rotor will have three layers of 12 blades each. The stator blades will be coupled to six transmission lines, which will run to the dee. The rotors will operate near rf ground potential. This design permits effective magnetic shielding of the rotor to minimize eddy current losses. Excitation of the dee will be provided by two grounded-grid, triode oscillators cross-coupled to quarter-wave stubs on the two sides of the dee. (auth)

28033 EXTRACTION FROM THE MODIFIED NEVIS SYNCHROCYCLOTRON. Cohen, R. (Columbia Univ., New York); Martin, E.; Ziegler, K.; Ohnuma, S. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 434-7(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Extraction studies indicate that the largest turn separation is obtained using a peeler-regenerator for the excitation of the radial oscillations. An additional time varying magnetic bump to increase the duty factor of the machine will be used. This bump will be used to keep the beam away from peeler-regenerator during the acceleration cycle. After reaching the final energy the radio frequency will be cut off, and the time varying bump decreased slowly, thus moving the beam into the extraction system. This concept of the extraction system has been investigated using an orbit tracing program, which includes radial and axial motion as well as the coupling from radial to axial motion. The results indicate that one can expect a turn separation of the order of 1 in. at an azimuth where the mouth of a magnetic channel has to be inserted. If as expected, a turn separation of the order of 1 in. is obtained at the entrance of the extraction channel, then a channel which drops the field by 4 kG over a distance of 20 in. would be sufficient to lead the beam out of the accelerator. Because of space limitations (the vertical aperture at the extraction radius is only 6 in.) it will probably be necessary to use a square coaxial current channel with compensating iron shims. (auth)

28034 THE UNIVERSITY OF MARYLAND ISOCHRONOUS CYCLOTRON. Berg, R. E. (Univ. of Maryland, College Park); Bridges, J. F.; Jenkins, K. D.; (and others). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 438-41(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Design features of the University of Maryland Isochronous Cyclotron are discussed and a description of initial turn-on and operation is given. The four-sector magnetic field was designed with the aid of a one-third scale model magnet utilizing both the experience with the Grenoble cyclotron and computer studies at the University of Maryland. The original maximum design energy was increased to 140 MeV protons by modification of the spiral angle after full-scale magnet measurements. The dual rf amplifier chain (250 mW to 250 kW per channel) drives two dees independently in both push-pull and push-push modes over a frequency range of 10–22 MHz from 20 to 90 kV. (auth)

28035 DESIGN OF THE BEAM TRANSPORT SYSTEM FOR THE UNIVERSITY OF MARYLAND CYCLOTRON. Berg, R. E. (Univ. of Maryland, College Park). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 442-5(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The University of Maryland cyclotron will accelerate protons up to about 145 MeV, alpha particles up to about 190 MeV, and a variety of other nuclear projectiles to corresponding energies. The experiment space is on two levels, separated 25 ft vertically. Each area is subdivided into isolated experiment vaults. Five beam lines are provided in the lower area; beam switching and energy analysis of up to $\Delta E/E = 0.06\%$/mm fwhm will be obtained with a 40-in. dia, n = 0 circular pole magnet. Vertical translation of the beam to the upper area will be obtained by two 60-in. n = 0 double-focusing magnets which will also provide energy resolution up to $\Delta E/E = 0.012\%$/mm fwhm. With quadrupoles, it will be possible to operate this magnet system in any of three modes: (1) doubly dispersive, (2) singly achromatic, and (3) doubly achromatic. Beam switching in the upper area to any of six beam lines will be provided by a second 40-in. circular magnet. Design considerations are given, and problems discussed. It is envisaged that the beam transport system will be operational by January 1969, and preliminary operating results will be discussed as available. (auth)

28036 MAGNET AND EXTRACTION STUDIES FOR THE UNIVERSITY OF MARYLAND ISOCHRONOUS CYCLOTRON. Berg, R. E. (Univ. of Maryland, College Park); Delphin, P.; Kim, Hogil; Reiser, M. P. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 446-8(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

A short description of the computations and model studies for the University of Maryland four-sectored magnet and a brief review of important field parameters are presented. The important aspects of the extraction system will be surveyed. Particular attention is given to shaping the field such that problems created by the proximity of the $\nu_z = 0.5$, $\nu_r = 2\ \nu_z$ and $\nu_r = 1$ resonances are minimized. (auth)

28037 CENTER-REGION DESIGN AND INITIAL ORBITS IN THE MARYLAND UNIVERSITY ISOCHRONOUS CYCLOTRON. Reiser, M. (Univ. of Maryland, College Park); Zinneman, T.; Dupont, F.; Delphin, P. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 449-53(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The sector-focusing cyclotron at the University of Maryland is designed as a multi-particle variable energy machine capable of accelerating protons up to 145 MeV energy. It features a 4-sector magnetic field and a rf system with two 90° dees operating in either push-pull or push-push mode. To achieve a high quality beam at all magnetic field levels and in all modes of rf operation the center-region components (ion source, puller, etc.) were designed with the maximum degree of adjustability and flexibility permitted by space and other restraints. The design of the center geometry was based on detailed theoretical studies of starting conditions and initial orbits using a fully automated electrolytic tank system to obtain the electric field data. The desired magnetic field shape was determined in a $\frac{1}{3}$ scale model magnet. A unique feature in the central magnetic field design is an adjustable cobalt–iron plug which permits optimization of the vertical focusing frequency at various field levels while keeping the phase shift within tolerable limits. The radial variation of the focusing frequency ν_z was designed to provide balancing of the space charge forces. The basic concepts and general features of this central region design are discussed and first results of beam measurement during initial operation of the Maryland cyclotron are presented. (auth)

28038 CALCULATION OF THE CENTRAL ORBITS IN A COMPACT ISOCHRONOUS CYCLOTRON. Van Nieuwland, J. M.; Hazewindus, N. (Philips Research Labs., Eindhoven, Netherlands). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 454-8(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Especially for cyclotrons with axial injection of ions the orbits in the central region must be studied carefully. Computer aided calculations of the horizontal and vertical particle motion, using an electric field distribution measured in a magnetic analogue, are described. The rf-phase acceptance is calculated. The geometrical acceptance is discussed in terms of phase-space volume, to be matched by the axial injection emittance. This method appears to be a convenient tool in designing a cyclotron center. (auth)

28039 AXIAL INJECTION SYSTEM FOR A COMPACT ISOCHRONOUS CYCLOTRON. Hazewindus, N.; Peterson, A. (Philips Research Labs., Eindhoven, Netherlands). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 459-60(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

In the Philips prototype Compact Cyclotron ions (protons, deuterons, ${}^3He^{2+}$ and alfa particles) obtained from an external ion source, are axially injected into the median plane. The components of this system are described: Penning-type ion source, magnetic particle separator, focusing elements, and electrostatic deflector. The operation of the system is discussed and compared with theoretical predictions. Special attention is paid to the matching of the injection system and the central region. (auth)

28040 RF SYSTEM FOR A COMPACT ISOCHRONOUS CYCLOTRON. Geel, J.; Franken, A. J. J. (Philips Research Labs., Eindhoven, Netherlands). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 461-4(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The rf system of the Philips Compact Isochronous Cyclotron is described. It is built completely inside the vacuum chamber, allowing a very compact construction. The dees are situated in two opposite valleys of the four-fold symmetric magnet pole faces. Two rectangular coaxial lines are connected to the dees, terminated by movable shorting plates. The 15 kW rf oscillator, placed outside the vacuum chamber, is coupled capacitively to one line. The frequency range is continuously variable from 35 to 72 MHz, maximum dee voltage amounts to 23 kV. Operating characteristics are given. (auth)

28041 BEAM OPTICS AND SPACE CHARGE EFFECTS IN THE AXIAL INJECTION LINE FOR THE 88-IN. CYCLOTRON. Resmini, F. G.; Clark, D. J. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 465-70(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The design criteria and the beam optics properties of the new axial injection system for the 88-in. cyclotron are described. Three electrostatic triplets of 7.3-cm aperture are used on the line. The goals are to achieve a reasonable transmission efficiency and a wide range of matching between the phase space emittances of the external sources and the estimated cyclotron acceptance. In this connection the results of beam optics calculations are presented in some detail. The problem of the injection of space-charge limited beams has also been considered. The predictions, based on the integration of the Vladimirskij–Kapchinskij equation, indicate that currents up to 800 μA, for 10-keV protons can be transmitted and the desired optical properties concerned. The advantages and limits of a buncher operation, in the high beam intensities range, are finally discussed. (auth)

28042 DESIGN AND CONSTRUCTION OF THE AXIAL INJECTION SYSTEM FOR THE 88-INCH CYCLOTRON. Clark, D.; Burger, R.; Carneiro, A.; Elo, D.; Frazier, P.; Luccio, A.; Morris, D.; Renkas, M.; Resmini, F. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 471-3(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

A new axial injection system has been constructed to transport ion beams from external ion sources through the magnet yoke to the median plane of the cyclotron. With a bending magnet, beams from a polarized-ion source, a duoplasmatron ion source and an α-particle source can be accepted. A transport line of electrostatic quadrupole triplets brings the beam down into the magnet yoke. The beam diagnostic equipment in this line includes scanning wires, Faraday cups, and quartz plates. The beam then enters the magnetic field of the cyclotron, which acts as a strong half-solenoid lens, producing periodic waists in the beam as it approaches the median plane. The design and construction of the system are described. (auth)

28043 EXTRACTION FROM THE JUELICH 90-MeV-d^+ AEG-ISOCHRONOUS CYCLOTRON. Thimmel, H.; Wucherer, P. (Allgemeine Elektricitaets-Gesellschaft, Juelich, Ger.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 474-8 (June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The extraction system of the Jülich Isochronous Cyclotron was designed for an extraction at $\nu_r > 1$. It is composed of an electrostatic deflector, positioned in a hill sector, two totally screening compensated iron channels in the following valley, and an extraction channel in the fringing field of the next hill. At 90 kV/cm the deflector provides a turn separation of 3 cm at the entrance of the compensated channels. The septum is an 0.02-cm tungsten foil combined with some carbon plates. The disturbance of the internal beam caused by the channels was measured to be negligible because of an active compensation, indicated by a gradient probe. The extraction channel with an electrostatic deflector inside the iron channel matches the specified position, angle, and acceptance of the beam transport system. The radial emittance of the extracted beam guaranteed to be <20 mm-mrad; the axial emittance <25 mm-mrad. Measurements are being performed for d^+. The energy resolution, yet to be measured, should be $<3 \times 10^{-3}$ fwhm. External currents should be >10 μA for p, α, He_3^+ and >20 μA for d, the reached values are given. Precessional extraction giving external currents >40 μA has been tested at 60-MeV d^+. (auth)

28044 THE 4 MeV SEPARATED–ORBIT CYCLOTRON. Martin, J. A.; Howell, L. N.; Hudson, E. D.; Livingston, R. S.; Mann, J. E.; Mosko, S. W.; Richardson, E. G. Jr.; Worsham, R. E.; Ziegler, N. F. (Oak Ridge National Lab., Tenn.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 479-81 (June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Fabrication and installation of components of the Separated-Orbit Cyclotron Experiment (SOCE) are nearly complete. The SOCE will provide a unique facility for the evaluation of an operating SOC system to extend and complement earlier theoretical and experimental studies. The six-sector four-turn accelerator will provide maximum energies of 4 MeV for protons and deuterons and 8 MeV for $^3He^{2+}$ and $^4He^{2+}$ ions. The energy can easily be varied over a 3:1 range. Proton currents in the 10-to-20 mA range are predicted. Ions are injected into the SOC at one-quarter the final energy. The injection system consists of a duoplasmatron ion source and a 500-kV dc accelerator, followed by a three-cavity linear accelerator. Excitation tests have been completed on each cavity with its respective power amplifier. A magnetic field survey has been completed for one magnet sector and the results extrapolated to the other sectors. Trimming coils on each pole tip provide for final field adjustments. Injector testing is under way; initial operation of the complete machine is scheduled for early spring of 1969. (auth)

28045 TEST RESULTS FROM COAXIAL CAVITIES FOR SEPARATED ORBIT CYCLOTRONS. Ziegler, N. F. (Oak Ridge National Lab., Tenn.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 482-6(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Three different accelerating cavities were tested at ORNL for possible use in separated orbit cyclotrons (SOC). All cavities were operated at about 49.2 MHz and at, or above, design power levels. The largest of these cavities is a prototype for a 10 to 50-MeV proton SOC having a total of 15 beam holes and a maximum accelerating voltage of about 290 kilovolts. In cross-section, the prototype is a wedge-shaped coaxial line. Its overall width is about 230 in.; its height, 82 in.; and the maximum thickness, 67 in. Four tuners are located in the top of the cavity opposite the open end of the center stub for adjusting the cavity frequency and voltage distribution. The cavity was operated at various power levels up to a maximum of 66 kilowatts. At this power input the x-radiation near the cavity increased markedly with increasing power input. Some difficulty was encountered with multipacting, but the problem diminished steadily with operating time. The other two cavities tested are being used in the Separated Orbit Cyclotron Experiment (SOCE). One of the cavities is for use in the cyclotron and the other in the injector. Both cavities were operated under vacuum and at power levels in excess of that required. (auth)

28046 UNIQUE MECHANICAL FABRICATION TECHNIQUES ON THE BROOKHAVEN NATIONAL LABORATORY CYCLOTRON. McCracken, R. J.; Baker, C. P.; Mann, J.; Hessinger, J. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 487-91(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Described in detail are some new and different coil and liner fabrication, testing, and assembly techniques. The profile coils are different in that they are of only one layer and are placed in precision milled slots in the liner such that the centroid of the coil is located over the magnetic center of the machine preventing the introduction of the first harmonic. Liner and coil fabrication techniques are discussed. All mechanical movement of the machine is hydraulically actuated including the clamping of the cantilevered dee. Specific applications of hydraulics to accelerators in general are discussed. (auth)

28047 IMPROVEMENTS IN THE MICHIGAN STATE UNIVERSITY CYCLOTRON RF SYSTEM. Johnson, William P.; Sigg, P. K. (Michigan State Univ., East Lansing). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 492-4(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

A new dee voltage amplitude regulator has been built and should lead to a factor of two improvements in the energy resolution of the MSU cyclotron. The rf drive to the final amplifier is regulated at low levels via an FET tetrode amplifier. The gain of the FET is controlled by a signal proportional to the difference between a reference voltage and a voltage corresponding to the sum of the two dee voltages. Protective circuits are included which remove rf drive to the final amplifier in the event of severe sparking in the dee cavity. Peak-to-peak noise levels on the dee voltage of less than 0.07% are achieved and with careful adjustments noise levels of less than 0.05% have been obtained. Since the cyclotron is usually operated with internal beam pulse-widths of less than 0.7 ns, corresponding to an energy spread due to phase width alone of 0.07%, noise on the dee voltage makes a significant contribution to the over-all energy resolution of the external beam. (auth)

28048 LOW POWER MAGNETIC CHANNEL WITH DIPOLE COMPENSATION. Khoe, T.; Benaroya, R.; Livingood, J. J.; Ramler, W. J.; Wesolowski, W. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 495-9(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

A magnet channel capable of guiding deflected 60-MeV protons through the fringing field of an AVF cyclotron without perturbing inner orbits, has been tested in a 0.4-scale model. The full scale channel will be composed of a 1010 steel cylindrical shell 3.00 in. OD, 1.18 in. ID, and 10 in. long with an external dipole winding extending to 5.92 in. OD. The dipole coil is approximated by dividing the winding into 16 sections, with centers 22.5° apart, and by making $N_\theta = N_0 \cos \theta$, where N is the number of turns in a section and θ is the altitude angle of the center of a section. Scaling the model measurements to full size, the power is 14 kW with $^3/_8$-in. square OD and $^1/_8$-in. round ID water-cooled copper conductors at 330 A, and the field halfway inside the channel is reduced from 7000 to 90 G, with a 20 G/in. gradient across the ID on the median plane. As close as 5 in. from the channel's edge, the first harmonic introduced is 1.1 G. Without dipole current, the field in the channel is 1560 G with a 16.2-G first harmonic at the same distance. (auth)

28049 MAGNETIC EXTRACTION CHANNEL FOR A 30-INCH AVF CYCLOTRON. Hendry, George O.; Tom, James L. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 500-3(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

An internally mounted magnetic channel is used to provide optimum external beam quality in a 15-MeV cyclotron. This magnetic channel is formed of several sections and placed after the electrostatic deflector. The sections of the channel are designed to provide sufficiently strong horizontal focusing to compensate for the normally horizontal defocusing forces generated by the cyclotron fringe field. The horizontal focusing is generated by causing a uniform gradient reversal in the fringe field. This field change is also designed to provide the best beam emittance at the cyclotron exit port. Various channel section profiles were studied and the resultant channel geometry and field gradients are presented. The compensating channel section gradients were optimized by a linear programming method known as computer code 4P as described by Meads. An integral part of this program involves setting realizable constraints on the channel sections, such as maximum possible gradients and acceptable phase widths and divergences. The resultant beam quality for such a channel was measured by observing the phase space of the external beam; the results are presented. (auth)

28050 BEAM LOSS DUE TO THE $\nu_r - \nu_z = 1$ AND THE $3\nu_r - \nu_z = 3$ RESONANCES. Mallory, M. L. (Oak Ridge National Lab., Tenn.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 504-7(June 1969).

In the Oak Ridge Isochronous Cyclotron (ORIC) there has been unexplained loss of proton beam near the maximum radius at the highest energies. Recent successes in computing the trim-coil currents have assured that the magnetic field is sufficiently isochronous and have permitted confident comparison of computed orbit properties with observed beam behavior. A study of computed orbit properties for high energy proton acceleration suggests that the beam is passing through the $\nu_r - \nu_z = 1$ resonance. The computed and measured radii for beam loss are in excellent agreement. The computed orbit data suggest the beam is also passing through, and in some cases closely following, the essential resonance $3\nu_r - \nu_z = 3$. In this latter case it has proved very difficult to accelerate the beam to full radius. It is anticipated that proper adjustment of the valley coils (which can vary the vertical focusing strength over a wide range) will avoid these coupling resonances, or will enable the beam to pass through them rapidly. (auth)

28051 MESON CHANNEL DESIGN FOR THE SREL SYNCHROCYCLOTRON. Funsten, H. O.; Siegel, R. T. (Coll. of William and Mary, Williamsburg, Va.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 508-9(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

A pion–muon channel has been designed for internally generated mesons from the NASA Space Radiation Effects Laboratory 600-MeV synchrocyclotron. The channel, similar to those at CERN and Chicago, consists of three sections: a main section with 24 identical 11-in. bore quadrupole magnets, an input matching section consisting of a quadrupole doublet for matching to the meson emittance from the cyclotron, and an output section consisting of a bending magnet followed by a horizontally focussing 11-in. bore quadrupole. Computer programs using quadrupole transfer matrices including linear magnetic fringe field effects have been used to optimize the meson flux. The main section quadrupoles have terraced pole tips and achieve a gradient of 2.4 kG/in. Movable channel mounting has been incorporated with pillar shielding to facilitate reorientation of the channel with respect to the cyclotron to change mean pion momentum entering channel. (auth)

28052 NAL BOOSTER AND STORAGE RING RF SYSTEMS. Dinkel, J. A.; Kerns, Q. A.; Klaisner, L. A.; Tool, G. S. (National Accelerator Lab., Batavia, Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 510-15(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The NAL booster-accelerator radio-frequency system design is described in detail. This rapid-cycling system is ferrite tuned from 30 MHz to 53 MHz. Each high-power module has an rf-output rating to 100 kW provided by a cascode amplifier which is a removable part of the cavity assembly. Ferrite power dissipation is minimized by adjusting the rf voltage to that required by the beam's momentum spread and using a second harmonic guide-field component to shape the rf-voltage envelope. Ferrite ring size has been reduced to eight inches o.d. by using a number of parallel tuning stems in the 140-deg drift-tube cavities. The low-level portion of the system corrects for both systematic and nonsystematic tracking errors using a single set of wide-band beam sensors. Provisions are included for controlling the shape of longitudinal phase space for matching into the main ring and for adjusting the phase of the booster bunches relative to the stationary main ring buckets before transfer. In the design of a storage ring rf system, the control of the beam-cavity interaction is a basic problem. An arrangement of TEM mode cavity, cascode power amplifier, beam pickup and feedback control loop is described to achieve a cavity-gap impedance of about 10 ohms over a frequency range from the synchrotron oscillation frequency (a few Hz) to the higher harmonics of the bunch frequency. The design center radiofrequency is 53.1 MHz. (auth)

28053 ELECTRONIC SYSTEM OF THE 70-GeV PROTON SYNCHROTRON. Mints, A. L.; Gertsev, K. F.; Gutner, B. M.; (and others) (Radiotechnical Inst., Moscow). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 516-18(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Design principles and main performance data of the electronic system used in the Serpukhov proton synchrotron, to generate the accelerating field, to control acceleration processes, and to measure accelerated beam parameters are described. (auth)

28054 CALCULATED BEAM-LOADING EFFECTS IN THE NAL MAIN RING RF SYSTEM. Rees, G. (National Accelerator Lab., Batavia, Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 519-25(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The synchronous transfer of beam from the booster into the NAL main ring results in a partial turn of beam circulating in the main ring. This situation presents large step changes in beam-loading to the main ring rf system which must be handled by the cavity voltage regulation circuit. The behavior of the main ring rf system under these conditions has been studied with the aid of the Continuous System Modeling Program (CSMP). This program provides an analysis of system behavior starting with a system block diagram and a description of the driving functions. Nonlinear elements and functions may be included. The rf system under study and the response predicted by the program to a variety of beam-loading conditions are described. The block diagram computer analysis technique is discussed and use of the CSMP program is described. (auth)

28055 DIELECTRIC-LOADED SLOW WAVE STRUCTURE FOR SEPARATION OF RELATIVISTIC PARTICLES. Chang, Christopher, T. M.; Dawson, John W.; Kustom, Robert L. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 526-30(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

A dielectric-loaded structure in which the phase velocity of the propagating electromagnetic fields is less than the speed of light is proposed for use as a traveling wave particle separator. The structure supports propagating modes which have suitable transverse deflecting fields and which have frequency, phase velocity characteristic (dispersion relation) which allows the device to be operated at different momenta by changing the frequency. Typical operating frequencies lie in the range of 1 to 5 GHz depending on the momentum range of the particles. A description of propagating modes with suitable deflecting fields and other degenerate modes is given. The means of excitation, power requirements, dielectric losses, and efficiency of the structure are also discussed. Results of experimental work which support the validity of the description of the fields and modes are presented. In addition, some computer results on beam dynamics within the structure are discussed. From these considerations it appears that a practical device providing reasonable aperture could be built with suitable low loss dielectric and available klystrons. (auth)

28056 LONG-PULSE RADIO FREQUENCY SEPARATOR TEST FACILITY. Dawson, John W.; Moretti, Alfred; Peerson, Joseph J. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 531-2(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

A long-pulse line-type modulator has been designed to operate either one or two SLAC klystrons from a common pulse transformer. The modulator is capable of driving two klystrons to a peak power of 80 MW, 250 kW average for 55 microsecond pulses or one klystron to a peak power of 40 MW, 125 kW average. The klystrons are driven from the same pulse transformer to reduce phase differences of the outputs of the klystrons. The modulator consists of two 50-microsecond pulse-forming networks which can be operated individually to drive a single klystron, or in parallel to drive two klystrons. The pulse network can be charged to 50 kV through a charging inductor from a 25-kV, 10-A dc supply. The charged network is switched to the pulse transformer by a 50-kV hydrogen thyratron. Details of the modulator are presented with test results on the operation of the SLAC klystron at long-pulse, high peak power. Preliminary tests of the SLAC klystron have shown a capability of 10 MW for 55 μs with no damage to the tube. (auth)

28057 IMPROVEMENT IN THE RF CAPTURE BY USING NONSINUSOIDAL ACCELERATING VOLTAGES. Bertuccio, T.; Isaila, M.; Kirchgessner, J.; Koepke, K.; Larsen, F.; Passner, A.; Prelec, K. (Princeton-Pennsylvania Accelerator, Princeton, N. J.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 533-4(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

To improve the RF capture in PPA, experiments have been made with higher harmonic terms added to the accelerating voltage. Although the idea has been known for some time, it has been tested only very recently. Computer calculations have shown that by adding the second harmonic it should be possible to increase the synchrotron phase-space acceptance of PPA at capture by a factor of 2. Since the synchrotron acceptance increases with energy, second harmonic needs to be added only during the first few milliseconds. For a test, one of the existing drift tube stations was modified to produce the required second harmonic voltage. Each of the remaining three drift tubes then has to produce a higher fundamental voltage. Phasing is done via a second harmonic reference which has the desired phase relation to the fundamental. This signal is generated in the master oscillator. Initial experiments have yielded an intensity gain in excess of 50%. Although only described for PPA, the method can easily be adapted to other machines. (auth)

28058 ENGINEERING STUDY OF THERMAL PROBLEMS IN FERRITES OF AGS ACCELERATING CAVITIES. Jablonski, E.; Buchanan, V. J. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 535-9(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Expressions for radial and transverse temperature profiles in a ferrite disc heated internally by a high frequency alternating magnetic field of an accelerating cavity were developed from Fourier's equation for heat conduction. Analysis was based on a heat dissipation method presently used in the AGS accelerating cavities. In this method, ferrites are sandwiched between solid copper discs which are water-cooled at the outer edge. Temperature functions thus developed were used in equations for thermal stresses to determine the pattern of stress distribution and temperature gradients inside ferrites. Numerical results have shown that the present method of heat dissipation would be inadequate to cool the larger ferrites that are required in accelerating cavities of the AGS Conversion Program. However, a cooling plate with internal water passages was found to be an effective meliorator of thermal stresses. Derived equations are general in character and could be applied to similar problems of heat dissipation. (auth)

28059 APPLICATION OF THE TWO-POWER-SUPPLY METHOD TO THE FERRITE BIAS OF AN RF RESONATOR OF A RAPID-CYCLING SYNCHROTRON. Reginato, Louis L.; Smith, Bob H. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 540-2(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The ferrite bias equipment for the rf resonators of high-repetition-rate synchrotrons is expensive. This is a result of the high voltage necessary to overcome the back emf of the unsaturated ferrite at the beginning of the sweep, and the high current necessary to saturate the ferrite at the end of the sweep. For the high-frequency resonators of the Omnitron, which sweep in 6 ms, the initial voltage required is 90 V but drops to 20 V during the first ms, when the current reaches one kA. The voltage remains low for the remainder of the sweep, while the current increases to 20 kA. To meet these requirements as inexpensively as possible, a pulse-type power supply is used during the first ms, and a high-current power supply through the remainder of the sweep. Smooth current transfer is an inherent property of the circuit. Inductance, which is surprisingly costly, is kept to a minimum by a sandwich bus bar technique. An SCR switch reverses the current every other sweep, so that the full hysteresis loop of the ferrite is used. A regulator circuit forces the bias current to follow a reference pulse. (auth)

28060 NON-LINEAR EFFECTS IN LINEAR FERRITES AT HIGH RF FIELDS. Rakowsky, G.; Travis, A. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 543-5(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Recent tests on ferrite materials being considered for new AGS Conversion accelerating cavities have brought to light non-linearities which can cause instabilities at high rf fields. The most troublesome non-linearity in this respect is the variation of incremental permeability as a function of rf flux density. A parallel resonant LC circuit, with ferrite as the inductive element, exhibits a skewed response curve which may become multiple-valued at sufficiently large amplitudes. All the high-Q ferrites under consideration exhibit such instabilities and may in fact limit the peak rf voltage at which the new cavities may be operated. A circuit model has been analyzed and results compared with measured data. (auth)

28061 DIGITAL MEASUREMENT OF FERRITE HYSTERESIS LOOPS. Katz, J. E. (Univ. of California, Berkeley); Kerns, Q. A.; Sandberg, B. R. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 546-50(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The input data needed for engineering computations on ferrite for cavity tuning are almost nonexistent in industry or private research. It would appear that the accelerator designer's choice is either to accept crude input data and play safe by overdesign, or take time out to assemble a measuring system adequate for close design. A digital measuring set for major and minor hysteresis loops in ferrite is described. The B integrator operates under a hardwire program with digital drift and zero correction. A small control computer formats the output data for typewriter, cards, paper tape, or magnetic tape. A code, run on a separate computer, fits the measured data points to any one of several compact series expressions for the B-H loop, presents analog plots, and derives numbers for permeability, stored energy, and Q. (auth)

28062 SIMPLIFIED DESIGN TECHNIQUES FOR DISTRIBUTED POWER AMPLIFIERS FOR SYNCHROTRON AND CYCLOTRON DRIVER APPLICATIONS. Gagnon, William L.; Smith, Bob H. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 551-5(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The design of distributed power amplifiers has been simplified through the use of a set of design charts and simplifying circuit techniques. A circuit in which the anode and grid lines are built from bridge-T constant-resistance networks seems to be best. These lines have an image impedance that is resistive and of constant value for all frequencies, and therefore do not require terminating half sections. For a given characteristic impedance and shunt capacitance, the bridge-T lines have about twice the bandwidth of the constant-K lines. The design of the ferrite transformers for matching the anode and grid lines to standard line impedances has been simplified by means of design charts and tables. These amplifiers are simple to build, very stable, and require no experimental adjustment for satisfactory operation. A 3.5-kW amplifier that operates from 1.5 to 75 MHz is used to illustrate the technique. (auth)

28063 ELECTRICAL BREAKDOWN OF VACUUM INSULATED ELECTRODES UNDER RADIO FREQUENCY STRESS. Kustom, Robert L. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 556-7(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The theories which have been proposed to explain the catastrophic breakdown of vacuum insulated electrodes have considered initiation of the process by electrons, ions, electrons and ions, or massive microparticles. Analysis indicates that under stress by radio frequency fields in the range of 20 to 120 MHz electron-induced breakdown would be slightly affected and ion-induced breakdown would be measurably altered. Apparatus that can compare electrical breakdown of electrodes operated at 60 Hz to radio frequency has been built. A relatively low voltage, high power cw radio frequency signal is transferred to high voltage across the electrodes in a coaxial resonator. Radio frequency voltages in excess of 400 kV should be possible with this system. Measurements will be made at discrete frequencies of 20, 40, 60, 100, and 120 MHz. Vacuum on the order of 4×10^{-8} torr is attained with an oil-free pumping system of cryosorption and ion pumps. The program is in the initial stages of operation. (auth)

28064 NUMERICAL DESIGN OF THE SHAPE OF AN AZIMUTHALLY SYMMETRIC RF CAVITY THAT RESONATES AT GIVEN FREQUENCIES AND HAS ZERO RESPONSE AT OTHER SPECIFIED FREQUENCIES. Younger, Francis C.; Means, Philip F. Jr. (Brobeck and Associates, Berkeley, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 558-9(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The vector wave equation is formulated in terms of rH_ϕ, using finite difference methods and applied to a series of lattice points in the r-z plane. The resonant frequencies are determined by solving an eigenvalue problem where the dimension of the eigenvectors is equal to the number of lattice points. The nonuniform lattice spacing in the radial direction is chosen such that the operator matrix is symmetric and banded, simplifying the solution of the eigenvalue problem. For the eigenvectors associated with a given cavity shape, the resonant frequencies are obtained for perturbations of the boundary by the Rayleigh–Ritz Method. The set of perturbations is then formulated into a linear programming problem whose solution yields the optimum cavity shape. (auth)

28065 SAFETY GUIDELINES FOR ACCELERATOR INSTALLATIONS. Hernandez, H. Paul (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 560-7(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The AEC safety guidelines for high energy accelerator facilities are reviewed together with other guidelines and codes. Some current safety problems are also discussed. There appears to be no shortage of knowledge, but collecting rules is not the total answer to safety. One has some guidelines that are followed, but the correspondence is not always too clear between what is written and what is practiced. (auth)

28066 TABLES FOR THE DETERMINATION OF THE LATERAL SHIELDING REQUIREMENTS OF HIGH ENERGY ELECTRON AND PROTON ACCELERATORS. O'Brien, Keran (Atomic Energy Commission, New York). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 568-9(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Neutron dose-equivalent rates transmission tables for lateral accelerator shielding have been calculated to assist a shield designer who needs realistic shielding data in a short time, and who may be required to readjust his results frequently as machine design is modified. In one case an average shielding material having the properties of aluminum is assumed, and the hydrogen concentration is varied to account for differences in water concentration; in another, an iron shield is assumed. The geometry is cylindrical, neutrons being produced in a central accelerating structure of iron or copper, and absorbed in side-walls parallel to it. The neutron source is assumed uniform and infinitely long, which for most purposes means on the order of 10 meters long. The tables apply to electron and proton beams accelerated to energies greater than 0.8 GeV. (auth)

28067 RADIATION STUDIES AROUND EXTRACTED PROTON BEAMS AT NIMROD. Shaw, K. B.; Stevenson, G. R. (Rutherford High Energy Lab., Chilton, Eng.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 570-4(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Measurements are reported of the major dose contributing components of the secondary radiation produced by the interaction of 7-GeV particles in external targets. The production, composition, transmission, and energy spectrum of these particles have been studied and the possible variations in spectra are discussed. Standard dosimetry techniques were used involving flux-density determination from activation detectors and dose-equivalent estimation by threshold techniques, films, and thermoluminescent detectors. Measured values of neutron flux density are compared with those calculated for a simple shield model. (auth)

28068 GAMMA RAY BACKGROUND ANALYSIS AT THE NASA LANGLEY RESEARCH CENTER SREL 600-MeV PROTON SYNCHROCYCLOTRON OF THE RELATIVELY SHORT AND LONG-LIVED GAMMA RAYS. Rind, Emanuel (Langley Research Center, Langley Station, Va.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 575-6(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The NASA Langley Research Center Space Radiation Effects Laboratory 600-MeV proton synchrocyclotron has a very complex beam transport system. Experiments are often conducted at various points along this system. For this reason, and from the health physics standpoint, the gamma-ray background should be known. Various pertinent stations were studied five days post irradiation and directly after operating the beam degraded from 300 MeV to less than 100 MeV for one-half hour. Spectra for the stations were obtained with a 2 × 2 NaI (Li) scintillator, and the activation analysis was performed by stripping technique. The analyzed results for a typical station for the relatively short and long-lived gamma rays are presented including the energy, relative intensity, daughter radionuclides, half lives, and reactions. The experimental setup, calibration, and other pertinent information are included. It is interesting to note that fission products from these proton energies have been reported by both CERN and ORNL; the SREL experiments corroborate their results. Also, although very complex spectra were produced, almost every peak corresponding to the daughter radionuclides was analyzed. (auth)

28069 PRIMARY HAZARDS OF PARTICLE ACCELERATORS. Hall, Wm. Cornelius. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 577-8(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Particle accelerator safety problems are primarily those of activation and shielding. The phenomena of activations from various nuclear particles and from photons is relatively well known. Use of low activation materials at exposed locations and of adequate shielding at all locations is basic to the art of constructing an accelerator facility that will be safe in operation and will need minimum cooling time. Side effects must also be considered relative to safety. Electricity, heat, or even sound in the wrong place may prove hazardous both to personnel and to a successful experiment. The know-how and the materials that exist today permit the design and construction of particle accelerators, large and small, of various types, all radiologically safe both in operation and after shutdown. Good design and construction followed by the routine safety procedures associated with such facilities will accomplish this objective. (auth)

28070 FAST PROTECTION SYSTEM FOR LINEAR ACCELERATORS. Van Buren, Dale T. (Los Alamos Scientific Lab., N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 579-81(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The high beam current in the Los Alamos Meson Physics Facility accelerator constitutes a safety hazard to both personnel and equipment. It must be possible to inhibit beam injection rapidly and reliably in the event any condition occurs along the accelerator which will result in a beam spill. A hardware fast-protect system based on transmission line principles has been developed which will provide a beam-inhibit signal in less than 10 μsec after detection of an alarm condition anywhere along the 3000-ft length of the facility. An indication that a shutdown occurred, along with an identification of the source which initiated it, are passed through an interface to the central control computer. The hardware is fail-safe to single component failures and features computer testing of the system integrity. Some details of the design related to device selection, ground isolation, and fail-safe features are discussed. Results from a prototype system installed on a computer-controlled electron linac are presented. (auth)

28071 THE UNIVERSITY OF TORONTO SOLID-STATE INTERLOCK SYSTEMS. Horrigan, E. W.; Millar, R.; Schwedtmann, K. (Univ. of Toronto). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 582-3(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The interlock system in use at the University of Toronto Linac Laboratory is based on solid-state computer logic circuits. These eliminate many of the problems associated with conventional relay interlock circuits (such as bulk, difficulty of modification, contact wear, and complexity of contact arrangements); they also make unauthorized tampering much more difficult. The system incorporates duplicated logic on all functions and an error check section, which senses logic malfunction and the existence of mutually contradictory inputs. The various interlock operating modes are programmed by means of plug-in program boards which allow operation only in the specific authorized mode. Selector switches allow logic levels to be fed to any interlock input, bypassing the selected input for test or verification purposes, but in so doing they break the main interlock output to ensure that no interlock is overridden without authorization. Authorized bypassing of minor interlocks requires a key held by the Chief Engineer. In addition, bypassing locks affecting personnel safety requires the use of a second key held by the Radiation Safety Officer. (auth)

28072 NEW PERSONNEL INTERLOCK SYSTEM AND PROCEDURES FOR THE RPI LINAC LABORATORY. Haken, J.; Morse, D. S.; Ryan, R. M. (Rensselaer Polytechnic Inst., Troy, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 584-5(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Experience indicates that periodic modifications to personnel interlock system operating procedures (nuisance modifications) increase user awareness. A modular interlock system which permits easy modification of the forced inspection sequence has been designed and installed at the RPI Accelerator Laboratory. The system provides for forced area inspection within specified time periods. Audible signals alert workers when the inspection is in progress. (auth)

28073 REMOTE MAINTENANCE CONCEPTS FOR THE LOS ALAMOS MESON PHYSICS FACILITY. Wilson, Mahlon T. (Los Alamos Scientific Lab., N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 588-93(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The LAMPF design beam of 1-mA, 800-MeV protons is capable of inducing thousands of curies of activity in targets and beam stops. Comparable activity is created in magnets, collimators, beam pipes, and shielding by secondary protons and neutrons. High activity levels exist over hundreds of feet of beam channel. The targets and stops are compact items that require routine replacement. They will be handled by mechanisms that position, cool, and vacuum seal. The mechanisms will be withdrawn into shielded containers for transport to a hot cell for target or stop replacement. Maintenance or replacement of all other activated equipment involves handling large sizes and weights on a nonroutine basis. Vertical access is provided to all equipment through movable roof shutters incorporated into the shielding. A shielded, floorless room is lowered into the shaft created by opening the shielding shutters. The room houses remote handling equipment capable of removing or performing minor repair work on all activated items. Lead glass viewing windows are mounted in the ceiling of the room through which operators standing on top of the room can observe their work. A self-propelled gantry transports the 200-ton room between work areas. The load is carried on four surplus military aircraft landing gear. (auth)

28074 GENERAL-PURPOSE SERVO-MANIPULATOR FOR REMOTE MAINTENANCE OF ACCELERATORS. Flatau, C. R. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 594-8(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Induced radioactivity in many accelerators is at a sufficiently high level so that direct maintenance or modification work on the machine is severely hampered or entirely precluded. To continue operations, one has to resort to some form of remote maintenance. A preferred technique would involve the use of commercially available mechanically coupled master-slave manipulators. However, since these cannot be adapted to the restraints existing in most accelerators, one would like to have an equivalent tool one could adapt. To fill this specific need, a prototype servo-master-slave manipulator was developed and built. It has an extremely compact slave arm coupled only electrically to the master, and is thus able to work in the confined spaces of accelerators, and do this even while the beam is on. Other essential features, like proportional control and bilateral force reflection are maintained, while overall dexterity and versatility is improved. This is achieved by improving frequency response and feel sensitivity, providing better articulation, and introducing continuously variable force ratios. Analysis of development cost shows that use of this arm is economically justifiable. (auth)

28075 APPLICATION OF REMOTE HANDLING IN THE CPS TUNNEL. Ellefsplass, M.; Horne, R. A.; Richter, W. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 599-603(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Two hands and a crane are controlled from the ring center via 300-m long cables and observed with three closed-loop TV-chains. This installation, with more than 30 remote controlled functions, is capable of performing work along 40 meters of the PS-ring-tunnel. The second hand, which has been developed at CERN, executes the more delicate work such as disconnecting ordinary water and electrical connectors of different types. One test operation was the removal of a vacuum tank with a septum magnet of the ejection system. Although this equipment was not designed for remote handling, only the connection to the power cable could not be removed from a distance. All the other work—vacuum connections to chamber and pumps, electrical and water connections, lifting out onto a chariot—was done with no one present in the ring tunnel. (auth)

28076 3-GeV PROTONS ON Pb NEUTRONS STREAMING THROUGH A LABYRINTH. Schimmerling, W. (Princeton-Pennsylvania Accelerator, Princeton, N. J.); Awschalom, M. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 604-5(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

A series of measurements are reported of the neutron fluxes along a labyrinth with four bends, leaking into an external beam cave of the Princeton–Pennsylvania Accelerator. The neutron fluxes were produced by the 3-GeV proton beam incident on 8-in. thick lead targets at the mouth of the labyrinth, and three feet upstream and downstream. Measurements were made by activation of carbon, sulphur, indium, and cadmium-covered indium at 26 locations along the labyrinth. The results have been normalized to 10^{10} incident protons/sec. A Monte Carlo calculation of the thermal neutron flux has been made by R. G. Alsmiller, et al. The calculations and the indium measurements agree very well. (auth)

28077 RADIATION DAMAGE STUDIES OF ZERO GRADIENT SYNCHROTRON MAGNET INSULATION AND RELATED MATERIALS. Markley, F. W.; Forster, G. A.; Booth, R. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 606-10(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Radiation effects on the electrical and mechanical properties of several insulating materials have been measured. These include several epoxy resin systems both glass reinforced and unfilled, two high temperature films, and a glass bonded mica. Samples were gamma irradiated under ambient conditions to 10^{10} rads at rates up to 10^7 rads per hour. The electrical tests given after irradiation were volume resistivity, voltage breakdown, dielectric constant, and dissipation factor. The samples were tested at 30°C and low humidity. No sharp changes occur that would predict electrical breakdown of magnet insulation. The voltage breakdown strength of the epoxy samples gradually decreased to about one-third of the original. Several different mechanical properties were measured to compare their radiation sensitivity and their practicality as radiation test methods. A new bulk shear test was selected as the preferred method; it gives good sensitivity, ease of fabrication and testing, small size, suitability to gamma ray or electron tests, and definitive numbers useful in stress calculations on dissimilar systems. For most systems rapid degradation begins at about 5×10^9 rads, although flexible systems lose their flexibility by 2×10^8 rads. (auth)

28078 MINERAL-INSULATED MAGNETS FOR HIGH RADIATION ENVIRONMENTS. Harvey, A. (Los Alamos Scientific Lab., N. Mex. Atomic Energy of Canada Ltd., Chalk River, Ont.); Walker, S. A. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 611-12(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

A mineral-insulated conductor for electromagnets exposed to high radiation fields is described. The copper conductor is insulated by compacted magnesium oxide powder, which has a very high tolerance to all types of radiation. The outer containing sheath is squared to improve the packing, and heat transfer. Coil configurations with either external cooling or with hollow internally cooled conductors, are described. Joints and terminations of the conductor are discussed. (auth)

28079 THE SPHERE DUMP: A NEW LOW-COST HIGH-POWER BEAM DUMP CONCEPT AND A CATALYTIC HYDROGEN–OXYGEN RECOMBINER FOR RADIOACTIVE WATER SYSTEMS. Walz, D. R.; Lucas, L. R. (Stanford Linear Accelerator Center, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 613-17(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

A new high-power beam dump concept was developed at SLAC. Its principal features are relatively low production costs, simple assembly procedures, compactness, and rather high power absorption capacity. The main power absorption medium is a water-cooled bed of 1 cm dia aluminum spheres contained in a tube. The dump is rated at 500 kW and a prototype of such a Sphere Beam Dump dissipated successfully 495 kW at an electron energy of 18 GeV. It is competitive with other designs down to 50 kW. The main features of the dump are discussed and illustrated. Heat transfer in the bed of spheres, flow and mixing of the coolant, detection of burnout, and the aforementioned experiment are treated in detail. Potential applications for other high-power absorbers are indicated. Radiolysis and resulting evolution of free hydrogen from such a dump and other water-cooled power absorbers presents safety and disposal problems at all high-current particle accelerators. A catalytic hydrogen–oxygen recombiner fully integrated into a closed-loop radioactive water system and interlocked with the accelerator operation was developed and built. A detailed description supported with illustrations is given with emphasis on operational parameters, instrumentation, safety, catalyst tests, and performance. (auth)

28080 THE RADIATION SHIELDING AND BEAM DUMPS FOR THE NAL 100-GeV PROTON STORAGE RINGS. Awschalom, Miguel (National Accelerator Lab., Batavia, Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 618-19(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The beam losses expected in the NAL 100-GeV storage rings are reviewed from the point of view of radiation damage to components and required biological shielding. It is shown that the required shielding is essentially the same as adopted for the NAL main accelerator: about 1.1×10^3 g/cm^2. The storage rings will hold 16 MJ of beam energy in each direction. In case of fast beam ejection (~7 μsec), this energy must be absorbed by a large enough mass to avoid excessive temperature excursions. It is shown that beryllium or graphite cores in a steel shield would make a satisfactory beam dump. (auth)

28081 EXTERNAL TARGET IRRADIATION FOR THE PRINCETON UNIVERSITY AVF CYCLOTRON. Foster, C. C.; Greenebaum, B.; Phillips, E. A. (Princeton Univ., N. J.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 620-1(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

A comparatively simple and inexpensive facility is being completed to irradiate targets in the external beam of the Princeton University AVF Cyclotron. The target can be removed and used relatively quickly. The target itself is held and cooled by a version of the Berkeley 88-in. Cyclotron target holder block, which also acts as a cyclotron beam stop. It is estimated, on the basis of calculations and Berkeley's experience, that the block will easily handle the 2.5-kW expected to be delivered with a 50-μA beam of 50-MeV protons, or similar beams of other ions. The target holder block is lowered into a vacuum chamber on a supporting column which provides the block with cooling water and electrical leads for beam and temperature monitoring. The chamber is surrounded by shielding to attenuate fast neutrons during bombardment and to protect personnel handling the block afterwards. After irradiation, the block is purged of water, vacuum is broken, and the block is lowered into a lead cart through a gate valve at the bottom of the facility. The block is then taken to a shielded handling area, where it can be disassembled quickly. (auth)

28082 SHUTTER AND COLLIMATOR WITH ROTATING RADIATION-COOLED ELEMENTS FOR THE BEAM FROM THE PRINCETON AVF CYCLOTRON. Foster, C. C. (Princeton Univ., N. J.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 622-6(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

A beam collimator and shutter assembly has been designed and fabricated to define and interrupt the high maximum areal power density (30 kW/cm^2) external beam anticipated for the Princeton AVF Cyclotron. Pairs of tungsten-coated graphite cylinders, which rotate at 300 rpm about parallel axes a precisely adjustable distance apart, define the beam in each of the horizontal and vertical directions. The thin tungsten coating is used to retain the good beam-defining properties of a heavy metal while minimizing the buildup of long-lived radioactive isotopes in the slit cylinders. A similar uncoated rotating graphite cylinder, which is raised and lowered by an air cylinder, operating in a fail-safe mode, functions as the beam shutter. The power of the beam incident on these cylinders is dissipated by thermal radiation to surrounding water-cooled structures. Tests with an electron gun show that the slit cylinders can successfully dissipate 20 kW/cm^2 with no indication of deterioration or overheating of critical components. (auth)

28083 IMPROVEMENTS IN LIQUID HYDROGEN TARGET TECHNIQUES. Hoenig, Mitchell O. (Harvard Univ., Cambridge, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 627-30(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

In the process of converting liquid hydrogen target systems from liquid cooling to mechanical refrigeration, new techniques have been developed to aid the high energy physicist. These include: thermal suppression of local boiling, target insulation by means of internal shielding, rapid transfer of liquid from thin wall target to safe container, and isolation of the liquid hydrogen in this condenser vessel to permit safe access to experiment. Hydraulic as well as refrigerating techniques used for 100-ml, 2-liter, and 6-liter targets utilizing 10 to 20 and 35 to 50 watt mechanical refrigerators are described. (auth)

28084 A LIQUID HYDROGEN TARGET FOR SLAC'S 30-mA ELECTRON BEAM. Bell, R.; Clay, H.; Mark, J.; Pierce, W. (Stanford Linear Accelerator Center, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 631-2(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

A unique liquid hydrogen target capable of handling SLAC's high current (30 mA), high energy (20-GeV) electron beam is described. A 35-liter liquid hydrogen reservoir is used to condense the gaseous hydrogen contained in the target flow loop. This loop consists of a 3-in. dia, 0.003-in. thick seamless aluminum target cell mounted in one leg of a U tube arrangement. In the same leg, a small axial fan submerged in the liquid hydrogen circulates the liquid through the target cell and heat exchanger. The top of the U tube is joined together with flexible metal hose which acts as the heat exchanger and completes the flow loop. Suspended from the rigid bottom of the loop are a dummy and a carbon target. The entire system can be positioned with any of these targets in the beam line by remote actuators. Density variations as high as 10% due to beam heating were experienced in similar targets which did not employ the circulating technique. Experimental results show that in the circulating target these density variations were reduced to less than ½% with heat fluxes as high as 5 kW/cm^2/cm of target length. (auth)

28085 REFRIGERATED LIQUID HYDROGEN TARGETS AT THE ZERO GRADIENT SYNCHROTRON. Roman, Richard D.; Guigler, R. M.; Peifer, J. A.; Kowalski, T. L. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 633-6(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Refrigerated LH$_2$ targets having a volume of 0.3 to 2 liters have been operated in high energy physics experiments on Argonne's Zero Gradient Synchrotron. These LH$_2$ targets use commercially available cryogenic refrigerators. Experience has shown these refrigerated targets are as reliable, safer to operate, less expensive to operate, and more versatile than the reservoir targets commonly used. Refrigerated targets use a closed loop, hydrogen condensing and recondensing design. A modular design of the target system has made possible the standardization of auxiliary equipment. The standard equipment has in turn been designed into self-contained, portable consoles and equipment carts which are easy to maintain, require fewer spare parts and can be located in easily accessible areas remote from the cluttered experiment site. The refrigerated target system consists of four major components; the universal refrigerator container to which the vacuum jacketed target is attached; the pump, valve and electrical distribution cart; the compressor; and the control console. For larger targets a design using a compact heat exchanger at the target has been proposed. This condenser would be cooled by a remotely located, commercially available, cold gas generating refrigerator. (auth)

28086 INSULATED TARGET INSTRUMENTATION FOR THE AGS SLOW EXTERNAL BEAM. Bennett, G. W. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 637-9(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Absolute measurements have been made of the charge transferred by 25-GeV protons from thin, insulated, aluminum plate targets in vacuum. The results are reported for various thicknesses, orientations, and bias. Beam flux measurements were made by means of the ^{12}C(p,pn)^{11}C monitor reaction using polyethylene foils. Applications of these targets to beam intensity, profile, and emittance measurements at the AGS are discussed, as well as the associated circuitry and the limitations of the technique. (auth)

28087 INSERTION AND EXTRACTION OF INTERNAL TARGETRY AT THE ZERO GRADIENT SYNCHROTRON. Cassidy, Thaddeus D.; Gorka, Andrew J.; Wehrle, Robert B. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 640-1(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

A new internal meson targeting system is in current use within the ring vacuum chamber of the ZGS. In this system, the target manipulators are changed without loss of the ring vacuum. The changes are accomplished with short interruption of useful beam time and with minimum radiation exposure to personnel. Two target manipulators operate on the track simultaneously supplying two secondary beams and an extracted proton beam from each machine pulse. The system consists mainly of the targeting manipulators, the insertion and extraction apparatus with an isolation chamber, and a multi-bus-bar track with a 100-in. linear positional potentiometer. Each manipulator is a separate unit with no connecting external mechanical drives or wires. Small wiper contacts supply all power and information. The lack of physical trailing connections allows the manipulators to easily shuttle in and out of the ring vacuum chamber through the isolation chamber's vacuum valves. Direct coordinate positional readouts are displayed in digital form for the operators. Circuits automatically compensate for the track not being parallel with the coordinate systems. The system has been operating successfully for one year. (auth)

28088 SELF-OPTIMIZING TARGET CONTROL SYSTEM. Potts, Charles W.; Marcks, Donald F. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 642-7(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

A unique control system to rapidly drive meson targets into critical position has been developed and used in the Zero Gradient Synchrotron. This time optimized system increases the spill time and provides new possibilities for beam handling. The motive force of this new system is a current driven coil reacting with the magnetic guide field. The driving coil holds the target in any desired vertical position without the need of mechanical stops. Repeatable position is maintained regardless of operational changes of magnetic field, times of targeting, and changing friction. For any given set of mechanical, magnetic, and electrical conditions, an optimal target positioning time exists. Attained optimal performance cannot be maintained by an open-loop system if even the slightest change in system parameters occurs. The self-optimizing target control system achieves the proper bang-bang servo performance by learning and storing information regarding behavior on previous cycles. Once positioned, the system transfers to a linear servo mode to maintain position. In the linear servo mode, programmed variations in target height may be made to complement an experiment. Target positioning times of 20 milliseconds have been realized with stability and repeatability. Greatly expanded utilization of this control system is planned. (auth)

28089 PRECISION GONIOMETER FOR USE IN ACCELERATORS. Thebado, E. A. (Cambridge Electron Accelerator, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 648-9(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

A very successful goniometer design has been in use at CEA. A reproducibility requirement of 0.2 milliradians maximum has been achieved over 140 milliradians (8°) in two crystal axes and one longitudinal axis. All materials are compatible with ultra-high vacuum requirements in the presence of high radiation. The goniometer was built to hold a diamond target to produce polarized photon beams. No deterioration of operating characteristics is observed after over 1000 hr of operation. (auth)

28090 LOW CONDUCTIVITY COOLING WATER SYSTEMS. Homsy, George; Jones, William J. (Cambridge Electron Accelerator, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 650-3(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

It has been estimated that upwards of 80% of all electrical power delivered to an accelerator must be dissipated as heat by means of low-conductivity cooling water. The following aspects are discussed: elementary chemistry; equipment necessary to produce and maintain low conductivity water; sources of and the processes involved in contamination of the low-conductivity water; corrosion of the distribution system and the heat loads; maximum conductivity that can be tolerated in different components; significance of potentials that may exist at junctions of dissimilar metals; level of personnel required to operate and maintain the equipment; pollution problems raised in the disposal of affluent chemicals employed in regeneration of resins; and safety; i.e., hazards involved in handling the acid and caustic solutions used in regeneration. (auth)

28091 ACCELERATOR COOLING-SYSTEM DESIGN AND ECONOMICS. Eno, E.; Carpender, W. P.; Litsinger, E. C.; Lyster, M. K. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 654-8(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The reported costs of low conductivity water (LCW) cooling systems for various accelerators range from $8.00 per kilowatt to over $50.00 per kilowatt not including water distribution. The reasons for such variations in unit cost are explained. The effects on the unit price of cooling towers, of heat exchangers, and of other components of a cooling system are analyzed for atmospheric conditions and geological location; maximum allowable temperature of the cooling water supply to equipment; maximum allowable temperature rise of the cooling water as it passes through the equipment; and poor control of the flow of the cooling water through the equipment. An analysis is made of the functional suitability and the relative costs of alternate methods of cooling. An examination is made of various types of LCW piping materials as to their suitability and limitations and as to their relative costs. Curves and tables are submitted as an aid for the preliminary estimation of cooling system costs for any particular accelerator. Methods are suggested for reducing the unit costs of cooling systems. (auth)

28092 FIELD DESIGN OF THE MAIN-RING BENDING MAGNETS OF THE NAL 200-GeV SYNCHROTRON. Lari, R. J. (Argonne National Lab., Ill.); Teng, L. C. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 667-71(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Two types of bending magnets are used to match the beam width in the separated function FODO lattice of the main ring of the NAL 200 GeV accelerator. Bending magnet B1 has an aperture of 5 × 1.5 in., an overall dimension of 25 × 16 in., and a 12-turn coil; bending magnet B2 has an aperture of 4 × 2 in., an overall dimension of 25 × 14 in., and a 16-turn coil. With proper geometry and a small amount of pole-face crenellation, the good-field regions of these magnets extend over ~80% of the aperture to beyond 20 kg. At 18 kg, which corresponds to 400 GeV, the saturation is only 3.7% and the excitation current is 4716 A. The quadrupole magnet has a useful aperture of 5 × 2 in., an overall dimension of 25 × 17 in., and four 17-turn coils installed in enlarged coil slots. The quadrupoles are excited separately from the bending magnets to provide tuning flexibility. With proper cross-section geometry and pole-face shaping the good-field region of the quadrupole extends over ~80% of the aperture to a field gradient beyond 250 kg/m required for 400 GeV. Most of the magnetic-field design is performed with computer programs LINDA and TRIM. The factors of consideration and techniques involved in the design are discussed. (auth)

28093 DIRECT POWERING OF THE 200-GeV SYNCHROTRON MAGNETS FROM THE UTILITY SYSTEM. Cassel, R. L. (National Accelerator Lab., Batavia, Ill.); Van Ness, J. E. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 672-6(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Providing power for the main magnets of the 200-GeV synchrotron includes the direct connection of static power converters to the power utilities, without the use of local energy storage. The engineering aspects of this magnet powering system are investigated. The power utilities response to the required power fluctuations, as well as the interaction of the power line stability on the magnet field regulation, is covered. The calculated effects of the performance of Commonwealth Edison Co. power distribution system under different load conditions are presented. Included are the dominant factors related to the distribution systems behavior. Regulation and repeatability calculations relating the normal power line fluctuations to the required field stability are evaluated. Measurements on the 345-kV power line to be used for direct pulsing are included and evaluated with respect to the overall system requirements. (auth)

28094 STATIC POWER SUPPLIES FOR PULSED LOADS. Fox, J. A. (Rutherford High Energy Lab., Chilton, Eng.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 677-81(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The paper describes the basis and results of the study into the possibility of supplying a large pulsed magnet load (of the 300-GeV type) directly from the public power system and thereby eliminating conventional MG sets. The factors involved are reviewed in terms of the accelerator and its performance and of public power system. Various methods are briefly described for stabilizing the pulse-induced voltage fluctuation with static reactive compensators. A guide to acceptable fluctuation limits and the significance (with practical examples) of transmission system R : X ratios are included. Considerations of the public power system in determining pulse load acceptability are described in detail. The paper includes the description and results of practical pulse tests on power systems—the 60-MW pulse tests (November 1967) on the U.K. system using the Nimrod accelerator as the load and the 160-MW pulse tests (June 1968) between the U.K. and French systems via the interconnecting submarine power cable across the English Channel. Conclusions are derived on pulse load acceptability in terms of specific European power systems and existing or proposed accelerators, practical limits and general guide lines, and the effect of future power system development on permissive pulse energy levels. (auth)

28095 PULSING THE ZERO GRADIENT SYNCHROTRON DIRECTLY FROM THE UTILITY LINE. Rohrmayer, Alfred; Sellers, John F. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 682-6(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The history of extended periods of lost experimental time due to failures of flywheel motor generator sets used by pulsed synchrotron magnets indicates a necessity for standby facilities. The idea of pulsing synchrotrons directly off the utility lines has become very active in recent years, and investigations have shown this to be the most attractive alternative for the ZGS. The switchover, in the event of an M-G set failure, can be made within a matter of hours; the first costs are lowest, operating costs are reduced, and reliability is increased; and it can be built in stages from partial energy to full energy capability. The first stage will be to install a 35-MVA transformer capable of pulsing the ZGS to an energy of 9 BeV with a line voltage fluctuation of less than 1%. Low voltage taps will be available for low energy pulsing to study the effects on the utility system. The second stage will provide for bypassing one-half of the rectifier supplies during flattop. This limits the voltage fluctuation to a value consistent with continuous operation. In the full energy stage, a second transformer will be added and the system KVARs will be reduced by switching precharged capacitors. (auth)

28096 TOLERABLE LIMITS OF VOLTAGE FLUCTUATIONS PRODUCED BY MAGNETS PULSED DIRECTLY FROM ALTERNATING CURRENT POWER LINES. Praeg, Walter F. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 687-91(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Switching magnets, for time sharing of beam lines, can be pulsed directly off the ac power line if it does not cause objectionable line voltage fluctuations. Switching circuits, which are less expensive and more reliable than conventional magnet power supplies, are often all that are needed. The results of extensive tests made to determine the limits of tolerable single-phase line fluctuations are reported. Of particular interest for beam lines of the Zero Gradient Synchrotron was a test to find the attenuation permissible for one cycle of the 60-Hz power line every two seconds. Other tests included multiple cycle attenuation at different repetition rates and square wave modulation of the ac power line. Thresholds of perception and irritation as functions of voltage attenuation were determined for viewing television, reading by incandescent light, and observing various sources of light. Observers used a five-grade opinion rating, and it was found that the percentages of the observers likely to hold each grade in a given instance followed a binomial distribution. The results enable one to calculate the permissible magnitude of pulsed current in a given ac power system. (auth)

28097 RIPPLE FILTER SYSTEMS OF THE ZERO GRADIENT SYNCHROTRON AND MEANS FOR LONG, MAGNETICALLY CONTROLLED BEAM SPILLS. Barsotti, Edward J.; Praeg, Walter F.; Stephenson, James M. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 692-6(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Ripple frequencies in the ring magnet guide field of the Zero Gradient Synchrotron (ZGS) range from a few hertz to several kilohertz. Filter systems that reduce the ripple components to negligible magnitudes are analyzed; and the use of these systems for long-magnetically controlled beam spills is described. High-frequency ripple is attenuated by a novel LCR filter. Low-frequency ripple is reduced by a feedback loop from $\dot{B}$ to the rectifier phase control of the ring magnet power supply. The attenuation of the mid-frequency components is accomplished with a feedback loop from $\dot{B}$ to a ripple bucking coil in each octant of the ZGS. Effects of these filter upon the quality of the rf controlled beam spill are shown. Two modes of operation for magnetically controlled beam spills without rf structure are discussed. In one mode the feedback to the low-frequency loop is transferred from $\dot{B}$ to a spilled-beam monitor. In the second mode both the low-frequency and the mid-frequency loops are driven from the spilled beam monitor. (auth)

28098 MODIFICATIONS TO THE ZERO GRADIENT SYNCHROTRON RING MAGNET POWER SUPPLY GENERATOR EXCITATION CONTROL. Sellers, John F.; Rohrmayer, Alfred (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 697-8(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The most desirable magnet voltage for the Zero Gradient Synchrotron (ZGS) should be constant during rectification and inversion and as low as required in flat-top. To reduce alpha control and ac and dc harmonics, the generator ac voltage should correspondingly increase during rectify, decrease in inversion, and be as low as possible during flat-top. This was obtained by providing an electronic generator field exciter with a very high ceiling voltage and a programmable reference in the generator voltage regulator. The complexity of the programmable reference made adjustment of the magnet pulse difficult. Furthermore, the transients encountered in the exciter current during transitions from rectify to flat-top and flat-top to inversion caused transients in the generator ac voltage, considerably distorted the ac voltage on the M-G set motor stator, and increased the mechanical oscillation on the M-G set shaft. It was, therefore, decided to apply a simplified scheme that would eliminate the transients at the price of a slightly higher generator voltage during flat-topping. This was accompanied by reducing the exciter ceiling voltage, eliminating the programming of the reference and setting it to constant values during rectify and invert, and by keeping the generator field current constant in flat-top. (auth)

28099 EXTENDED FLATTOP OPERATION OF BEVATRON RESULTS FROM STUDIES OF GENERATOR DOVETAIL FAILURE. Salsig, W. W.; Vogel, H. W. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 699-703(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

In December 1966, massive failures in the Bevatron generator pole dovetails were discovered before the trouble became catastrophic. Preliminary investigation indicated the cracks probably resulted from cyclic loads due to the increased speed range resulting from long flattop operation. New poles were installed and the generators returned to service with the length of flattop restricted. Regular inspection, including the monitoring of fatigue-sensing strain gages, was instituted. Fatigue tests of full-scale dovetails and fracture mechanics methods of analysis were undertaken. A few new cracks were initiated in the generators, and flattop length was further restricted. In addition to gathering mechanical information, a number of reconnections of the electrical converters to provide continuous power balance were tried and evaluated. A reconnection which greatly reduced the speed range without generating new undesirable vibrations was finally achieved. Since July 1968, the generators have been running with this new switching mode. Flattop lengths of 2 to 2.5 seconds, twice the length which caused the initial trouble, are now usual in operation, and all crack growth appears to have been arrested. (auth)

28100 FLAT TOPPING THE CEA ALTERNATING GRADIENT MAGNETIC FIELD. Averill, R. J. (Harvard Univ., Cambridge, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 704-5(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

A possible method of increasing the duty cycle of the CEA electron synchrotron to perhaps twice that now achieved by current pulsing a one-turn winding around all 48 synchrotron magnet back legs is described. A half sinusoid of current applied to the winding in such a way as to flatten the magnetic field at its maximum value can, in principle, increase the time when $\Delta B/B \leq 1/4\%$ from the normal 500 μsec to about 1 millisec. Several aspects of flat topping by this method are discussed, e.g., absolute energy effects, magnetic circuit effects, costs, and peripheral effects on radio frequency, and beam bumps. (auth)

28101 HIGH STABILITY, HIGH CURRENT, PROGRAMMED POWER SUPPLIES FOR NIMROD EXTRACTION SYSTEMS. Gilbert, F. S. (Rutherford High Energy Lab., Chilton, Eng.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 706-10(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The high stability step programmed power supply for the Nimrod 7-GeV proton synchrotron double extraction system now in successful operation is described, and the new high current 21,000-A pulsed power supply for septum magnets to be used on the future beam extraction system for a new Experimental Hall now under construction at the Rutherford Laboratory. The step programmed supply was developed to increase machine utilization by switching the proton beam between two beam lines in the same machine burst on flattop. The supply can switch a maximum of 500 A up or down in 10 msec and maintain a level stability or ±0.005%. The maximum current capability is 1600 A, with the current levels fully variable. Also, the pulsed power supply now under design and construction using a homopolar generator is described where the load current is programmed by a series transistor regulator. A review of other techniques considered is included to show reasons for the choice. The design specification requires that the current waveform should be trapezoidal and rise linearly in 200 msec to 21,000 A max. Stability during the flattop time should be within 0.02% inclusive of ripple. The flattop time is of the order of 600 msec, then the current decreases linearly to zero in a further 200 msec. The maximum pulse repetition rate is 25 ppM. General techniques are discussed together with particular emphasis on strobing of the precision demand reference and function. (auth)

28102 LARGE DC MAGNET POWER SUPPLIES AT SLAC. Berndt, Martin M. (Stanford Linear Accelerator Center, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 711-14(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Currently a total of six dc magnet power supplies, ranging in size from 1.6 to 6.0 MW are in operation. Five of these supplies are static converters, using step-down transformers and thyristors; the sixth one is a two-unit motor-generator set. Certain design criteria have evolved, dictated by specific needs at SLAC and by operating experience obtained over the 3-yr period during which this equipment was installed. Primary power distribution is at 12.47 kV. Vacuum switches in place of circuit breakers incorporating special protective equipment to prevent complications are successfully used to do the frequent switching required by the loads. Provisions are made to permit reconnection of the output for use with the various loads. All static converters use oil-filled transformers, mostly of special design. Twelve-pulse rectifier systems using SCR's are used throughout; they are operated in such a way that in at least one case the inherently poor power factor of phase-controlled converters can be improved. A not very successful attempt was made to build some of these power supplies on trailers to make the equipment portable. It was abandoned in favor of a different approach. (auth)

28103 RECENT WORK ON SUPERCONDUCTING SYNCHROTRONS. Lewin, J. D.; Smith, P. F. (Rutherford High Energy Lab., Chilton, Eng.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 715-16(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

A brief progress report is given on theoretical studies relating to superconducting synchrotrons, development of low-loss filamentary conductors suitable for pulsed operation, and plans for model magnet studies. (auth)

28104 MEASURED LOSSES IN PULSED SUPERCONDUCTING MAGNETS. Gilbert, William S.; Voelker, F. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 717-19(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The feasibility of pulsed superconducting magnets in accelerators depends critically on the generated heat that must be removed by 4.2°K liquid helium. The attendant temperature rise tends to drive the superconductor resistive, or normal. The energy loss for a cyclic sweep of magnetic field is akin to hysteresis, and for single-wire filaments, loss per unit volume is proportional to wire diameter. Practical accelerator magnets appear to require wire some 0.001-in. (25 μ) in diameter. Coextrusion of many filaments of ductile Nb–Ti embedded in copper or copper alloy provides the required fine filaments within a strong, high-current conductor. However, the normal material causes increased losses through electrically coupling the filaments. This coupling can be reduced with high-resistivity normal material and by twisting the entire matrix. Experimental loss data are presented on cyclic superconductor loss in two geometries; solenoid with 1.5-in. ID, 4.5-in. OD, 4.5-in. length, maximum field 55 kG; bending magnet (dipole) 3-in. ID, 5-in. OD, 15-in. length, maximum field 30 kG, random winding with epoxy binding. Conductors used are single core and multicore (filaments 0.001 to 0.002 in.), copper and Cu–Ni substrates, twisted and untwisted conductor. (auth)

28105 SUPERCONDUCTING SYNCHROTRON MAGNETS. Sampson, W. B.; Britton, R. B.; Morgan, G. H.; Dahl, P. F.; Blewett, J. P. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 720-22(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Recent technological developments indicate that superconducting magnets capable of being pulsed with low energy losses will be available in the near future. Experience obtained from the construction of superconducting magnets for beam handling applications has been combined with energy loss measurements to estimate the refrigeration requirements of a typical synchrotron magnet. Loss measurements are presented for twisted multifilamentary and braided conductors. These results are used to predict the loss that can be expected from a small-aperture dipole magnet. The use of iron to reduce the stored energy is also discussed. (auth)

28106 OPERATING EXPERIENCE WITH A SUPERCONDUCTOR MAGNET IN AN ACCELERATOR EXPERIMENT. Chamberlain, William (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 723-7 (June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

A superconducting solenoid was incorporated into a physics experiment at the LRL 184-inch Cyclotron. The magnet was kept superconducting for the entire run, July to December 1968. The solenoid has a $4\frac{1}{4}$ in. diameter warm bore and an overall length of $3\frac{1}{2}$ ft. The field intensity is 60 kg. The proposed conventional solenoid which it displaced was 11 ft long. Buried in a steel and concrete shielding wall, the solenoid was the least accessible of all components in the experiment. This condition imposed great emphasis on the reliability of the coil and cryostat structure. The cryostat is cooled by direct evaporation of liquid helium and liquid nitrogen. The liquid helium supply Dewar and vacuum pump are located 25 ft from the magnet in a region accessible only with accelerator beam off. Liquid-helium automatic-fill controls and liquid nitrogen supply Dewars are located 40 ft from the magnet in a region adjacent to the experiment control room. The solenoid was energized continuously by the power supply—no persistent switch was provided. The power supply is a solid state unit, rack mounted in the experiment control room. Data on liquid helium usage, magnetic field stability, and other operating characteristics are presented. (auth)

28107 HIGH FIELD IRON MAGNETS FOR OPERATION AT CRYOGENIC TEMPERATURES. Allinger, J. E.; Danby, G. T.; Jackson, J. W.; Polk, I.; Prodell, A. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 728-33(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Compact high field iron dipole, quadrupole and sextupole magnets, to be operated at cryogenic temperatures, are described. Behavior at low temperatures of exciting coils of pure aluminum and other materials is presented. Aberrations and excitation properties are discussed, as well as applications to future accelerators and beam transport hardware. (auth)

28108 HIGH-QUALITY NARROW QUADRUPOLE MAGNETS. Lou, K. H.; Hauptman, J. M.; Walter, J. E. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 736-7(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Narrow quadrupole magnets of two sizes (8 and 10 in. dia) were designed and are being built at Berkeley for use in Bevatron experiments. A prototype of the 8-in.-dia quadrupole was built, and magnetic measurements of the line integral show the design to have very small harmonic content. For a gradient of 2800 gauss/in., measurements at a radius of 3.67 in. give harmonic content, expressed as per cent of the second harmonic, of 0.1% sixth, ≤0.03% tenth, and 0.05% fourteenth. The magnet computational program (RNIL) that was used to develop the pole-tip contour is discussed and the calculated and measured harmonic values are compared. Mechanical design and fabrication procedures are also described. (auth)

28109 THE DESIGN OF THE ISR INFLECTOR. Kuhn, H.; Middelkoop, W. C.; O'Hanlon, H. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 738-43(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Protons with a momentum up to 28 GeV/c will be ejected from the CERN proton synchrotron, transferred via two beam transfer channels, each about 500 m long, and injected into each of the two intersecting storage rings being constructed at CERN. At $\frac{1}{4}$ betatron wavelength downstream of the injection septum magnet a fast pulsed inflector deflects the beam over a maximum angle of 2.5 mRad onto the injection orbit. This pulsed inflector consists of two line-type magnets each 1.5-m long, which operate in ultrahigh vacuum. The C-shaped ferrite magnets have a gap width of 44.5 mm and a gap height of 20 mm. The useful magnetic field region is 40 mm wide. A prototype inflector has been constructed consisting of all auxiliary electrical elements, one magnet and two UHV tanks. The 2.1-μs magnetic pulses are generated by discharging a coaxial high voltage cable via a deuterium thyratron into the magnet and its matched terminating resistor of 14 Ω. The droop on the magnetic field flat top is 1% and transients on the flat top and after the pulse are about ∓1%. The magnet has been tested at its maximum required operating voltage of 21.5 kV and at 25 kV in a vacuum of 10^{-10} torr. (auth)

28110 A GRADIENT FERRITE PULSED INFLECTOR FOR 130 MeV ELECTRONS. Dickinson, T. (Harvard Univ., Cambridge, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 744-5(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The injection path at the Cambridge Electron Accelerator requires a 10-mRad inflection to insert the 130-MeV electrons into the synchrotron orbit. The fast pulsed ferrite magnet described is in routine use as the inflector. The ferrite is shaped to provide the field gradient of 22% per inch required by the design of the injection transport system. The pulser uses a 50-ohm coaxial cable as a delay line. The 800-ns, 500-A pulse has a fall time of less than 100 ns, allowing a synchrotron orbit fill of approximately 85%. Electrical noise from the pulser is negligible outside the magnet tank and pulser cabinet. A summary of experience with the inflector is presented. (auth)

28111 DESIGN OF BEAM INFLECTOR MAGNETS FOR ULTRAHIGH VACUUM OPERATION. Hay, R. D. (Harvard Univ., Cambridge, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 746-9(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

There is increasing need for beam steering magnets designed to operate at vacuum between 10^{-8} and 10^{-11} torr in storage rings or particle accelerators. Increased radiation damage resistance is also desirable from a reliability consideration. Presented are details and vacuum performance of: a high current density dc septum magnet; a laminated core ac septum magnet; and high frequency ferrite pulsed inflectors, both high and low voltage. All are designed to the stated requirements. Various materials and design approaches are described, with emphasis on low outgassing inorganic materials and well vented structures. (auth)

28112 A SYSTEM FOR HIGH FIELD PULSING AND DEMAGNETIZING OF MULTIPOLE MAGNETS IN THE AGS. Vogel, U.

(Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 750-1(June 1969).
From Particle Accelerator Conference, Washington, D. C.
See CONF-690308.

A system is described where an ac generator is used to drive high oscillating currents into a load magnet. These currents decay to zero within a fraction of a second and can, therefore, be used for high field pulsing of multipole magnets in the AGS without affecting their remanent fields. The system makes use of the small leakage inductance of an ac generator. Prior to pulsing, the generator is run with field coils powered. At the proper time and phase, the generator output is switched into the load magnet and at the same time the field coil current is let decay to zero. By proper matching, the peak currents obtainable are of the order of the generator short-circuit currents. Results of tests made on a 125-kVA variable frequency generator are presented and discussed. It is shown that in such a system it is possible to drive a few kilojoules into load magnets within the first quarter cycle at a frequency between 10 and 60 Hz. Transients in the power line feeding the driving motor are negligible, since the above energy burst of kilojoules is supplied by the inertia of the generator rotor. The relations between the generator and load-magnet parameters for optimum coupling are discussed. (auth)

28113 SLOW EXTERNAL BEAM EJECTION MAGNETS AND POWER SUPPLIES. Hsieh, H. C. H.; Soukas, A. V. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 752-6(June 1969).
From Particle Accelerator Conference, Washington, D. C.
See CONF-690308.

Slow beam extraction at the AGS is based on a third-integral resonance scheme. The final step in the extraction process utilizes a two-magnet system. The first consists of a thin-septum kicker magnet capable of 1 milliradian deflection and the second is a thin-septum ejector magnet system capable of producing a 20 milliradian deflection at a momentum of 30 BeV/c. The efficiency of extraction is directly related to the septum thickness; thus, one minimizes this dimension subject to cooling limitations. The kicker magnet septum developed at Brookhaven is a 30-mil, 30-in. long edge-cooled type. The ejector magnet consists of three sections of total length ~7 feet and has two and three turns, water-cooled and insulated from each other with ceramics. The power supplies utilize series transistor bank regulators of 2000- and 6500-A current capability for a pulse length of 600 milliseconds. The dynamic power range of the ejector power supply is greatly enhanced by a liquid freon cooling system. The ratings are 50-kW continuous and 300-kW peak. Details of the protection circuits for both the magnets and power regulator systems are given. (auth)

28114 DEVELOPMENT OF THE FLOATING WIRE METHOD FOR THE CONTROL OF COMPLEX OPTICAL SYSTEMS. Pinel, J.; Tran, D. T. (Compagnie Generale de Telegraphie Sans Fil, Corbeville, France). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 757-61(June 1969).
From Particle Accelerator Conference, Washington, D. C.
See CONF-690308.

The systematic development of this method, and especially of the wire stability, has lead to improvements in the precision and simplicity of use, which are particularly interesting in the case of complex systems as compared to complete field plotting and computer calculations. The following cases are discussed: study of an achromatic system; use of stabilizing systems for complex systems; determination of conjugate points of complex systems; measurements of the optical qualities of a high resolution analyzer; and measurement of the properties of quadrupole lenses. (auth)

28115 DIFFERENTIAL ANALYSIS OF MAGNETIC FIELD MEASUREMENTS WITH APPLICATIONS. Young, Jonathan D. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 762-5(June 1969).
From Particle Accelerator Conference, Washington, D. C.
See CONF-690308.

The use of cubic spline fitting to compute, for the median plane ($z = 0$), the normal magnetic field component, $B_z(x,y,o)$ and its partial derivatives at specified mesh points (x_i,y_j) from a set of measurements of B_z is described. The construction and properties of the cubic spline fit are outlined. The results from the fit are used in interpolation and in approximating, off the median plane (for small z), the field components, B_x, B_y, and B_z at a specified point (x_0,y_0,z_0). The third order approximation makes reasonable the use of exact equations of motion in tracking charged particles through the magnetic field. In particular, the applications of this process of differential analysis of field measurements for the Bevatron (Berkeley) are discussed. (auth)

28116 COMPUTER SOLUTIONS FOR THREE-DIMENSIONAL ELECTROMAGNETIC FIELD GEOMETRIES. Nelson, D.; Kim, H.; Reiser, M. (Univ. of Maryland, College Park). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 766-7(June 1969).
From Particle Accelerator Conference, Washington, D. C.
See CONF-690308.

A computer program has been written utilizing the relaxation method for the solution of Laplace's equation in three dimensions. The program accepts boundary conditions of nonanalytic geometries and numerically solves for the potential at all points on a three-dimensional mesh. Unique features of this program include machine-coded subroutines for high speed convergence and the capability of an unlimited number of mesh points. The program is currently running on an IBM 360 and has been used to solve problems involving more than a million mesh points. (auth)

28117 TWO-DIMENSIONAL, UNIFORM CURRENT DENSITY, AIR-CORE COIL CONFIGURATIONS FOR THE PRODUCTION OF SPECIFIED MAGNETIC FIELDS. Morgan, G. H. (Brookhaven National Lab., Upton, N. Y.) IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 768-9(June 1969).
From Particle Accelerator Conference, Washington, D. C.
See CONF-690308.

A computer program has been written which can compute the two-dimensional, uniform current density, air-core coil configuration needed to produce a specified field (e.g., uniform field or quadrupole field) in simply-shaped regions such as ellipses, when the inner boundary of the coil coincides with the periphery of the region. The procedure is to expand in a Fourier sine series a correction curve to an initial approximate outer boundary. (auth)

28118 IRON MAGNETS WITHOUT AIR GAPS. Parzen, G. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 770-1(June 1969).
From Particle Accelerator Conference, Washington, D. C.
See CONF-690308.

It is sometimes desirable to fill the air gap of a conventional iron magnet with iron. In such a magnet the magnetic field depends very strongly on the saturation of the iron. The properties of such magnets were studied with the aid of a mesh-iteration magnet program. Results of the study are given and the techniques are described. (auth)

28119 INVESTIGATION OF THE CHARACTERISTICS OF CERAMIC CAPACITORS FOR SYNCHROTRON KICKER-MAGNET APPLICATION. Smart, David L.; Smith, Bob H. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 772-4(June 1969).
From Particle Accelerator Conference, Washington, D. C.
See CONF-690308.

The inherently low inductance, geometrical simplicity, and low manufacturing costs of ceramic capacitors make them attractive for kicker-magnet pulse lines, but their piezoelectric and dielectric hystereses complicate their use. The piezoelectric characteristic causes mechanical fracture of the ceramic if the electrical gradient is too high; the dielectric hysteresis limits the repetition rate because of the associated temperature rise. The voltage and temperature capacitance sensitivity does not appear to present a serious problem in this application, because the permissible gradient and temperature is limited by the other factors affecting reliability. These characteristics were measured for the most commonly used ceramics, and the results tabulated. From these data one can choose the best ceramic composition. The choice depends upon the repetition rate, pulse shape, and geometrical considerations of the capacitor. It is shown that properly designed ceramic capacitors are superior to other types for a kicker-magnet pulse line when the pulse length is sufficiently long to preclude use of a distributed line and when the rise and fall times are sufficiently short to make lead inductance significant. (auth)

28120 ELECTRICAL TESTS OF ZERO GRADIENT SYNCHROTRON MAGNET COILS. Burba, Kostas; Rohrmayer, Alfred (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 775-6(June 1969).
From Particle Accelerator Conference, Washington, D. C.
See CONF-690308.

A survey of the 16 most common electrical tests is discussed; and their applications to the Zero Gradient Synchrotron (ZGS) ring magnet, extraction, auxiliary, beam line transport, spark chamber, and bubble chamber magnet coils are described. Type, sequence, and timing of various tests during coil manufacturing, acceptance, and operational periods are outlined. Detailed information is given on test methods, values, equipment, procedures, and limitations. The descriptions of the induced and applied voltage tests for detection of shorted turns and the conductor joint tests are emphasized, since the methods applied differ from the tests applied in industry and other laboratories. Maintenance and trouble-shooting procedures are mentioned. (auth)

28121 EXPERIENCE WITH ALUMINUM COIL MAGNETS. Roskowski, Edward (Stanford Linear Accelerator Center, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 777-9(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

In the magnets where high current density within the coil area is not required, the use of extruded aluminum conductors can provide substantial savings in conductor and coil fabrication costs that more than offset the cost of additional iron required. Computer programs indicate that much can be done to minimize the iron required by making the coils into so-called "T" sections. Solutions to problems unique to the use of aluminum conductors are described. Two years experience with the use of water-cooled aluminum conductors in a mixed copper and stainless steel water distribution system shows no discernable corrosion effects on the aluminum conductors, the copper, or the stainless steel. (auth)

28122 EFFECT OF DISTORTED VOLTAGES IN EXPERIMENT AREAS AND SUGGESTED IMPROVEMENTS. Rohrmayer, Alfred; Stapay, Joseph R.; Vanderflught, Arnold G. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 780-1(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Most beam transport magnets in accelerator experiment areas are supplied by SCR-controlled power supplies. These cause notches in the ac supply voltage effecting the operation of various electronic equipment supplied by the same bus. The effect of voltage distortion on a representative cross section of electronic equipment has been investigated, and the limits of acceptable voltage distortion have been established. The voltage distortion and the interference to equipment can be reduced by proper system planning, such as providing separate equipment or instrument buses, and by redesigning power supplies, such as providing 12-phase instead of 6-phase rectification. It is also possible to improve the wave-shape of the voltage in existing installations and to eliminate the effect on equipment performance. This would require to supply each SCR-controlled power supply in series with a choke and to arrange filtering equipment in shunt with this choke. In most cases, a single capacitor will suffice to provide adequate filtering action. Oscillograms are included showing the distorted voltage and the voltage obtained with the suggested arrangement. (auth)

28123 THE POWER AND COOLING INTERCONNECTION OF THE 200-GeV SYNCHROTRON MAGNETS. Satti, J. A. (National Accelerator Lab., Batavia, Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 782-6(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The main synchrotron enclosure will be about $1\frac{1}{4}$ miles in diameter. Ninety percent of the circumference will contain few components other than focusing and bending magnets, so that the system for connecting the power and water to these magnets is designed to require a minimum of maintenance. The magnet power supplies and low-conductivity water circulating systems are located in 24 utility buildings spaced uniformly around the ring. For the bending magnets, 4-in. copper pipes serve as current-carrying bus as well as cooling water supply and return. Smaller copper pipes similarly serve the quadrupole focusing magnets. Each quadrupole magnet or pair of bending magnets is connected to the bus system by three copper pipes less than an inch in diameter, two of which carry current. The magnet coils each have several parallel cooling passages interconnected by an integral manifold with insulation provided by ceramic tubes. All connections in the cooling-bus system, the connections to it, and connections within the magnet coil manifolds are either brazed or welded. Semiautomatic pipe welding and cutting equipment will be used to install and remove magnets. (auth)

28124 ROUND TABLE DISCUSSION OF HEAVY ION ACCELERATORS: INTRODUCTION. Livingston, R. S. (Oak Ridge National Lab., Tenn.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 787(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The problems and techniques involved in the acceleration of heavy ions are discussed. (B.G.D.)

28125 LINEAR ACCELERATORS FOR HEAVY IONS. Schmelzer, Ch. (Univ., Heidelberg). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 788-90(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The problems involved in heavy-ion acceleration, especially acceleration of particles with mass number above 100, are described. The linear accelerator is shown to be the best suited system for heavy-ion acceleration. (B.G.D.)

28126 PROPOSED MODIFICATIONS OF THE BERKELEY HILAC. Main, Robert M. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 791-6(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Improvements are planned for the Berkeley Heavy Ion Accelerator which will make possible the acceleration of all elements from hydrogen to uranium to 7.5 MeV/nucleon. The improved system will consist of a 2.7 MV dc injector, a new 11 meter-long prestripper linac and the existing 27 meter long poststripper linac which will be extended to 37 meters. Baffles in the latter portion of this cavity will separate it into individually excited segments to provide completely variable energy from 3 to 7.5 MeV/nucleon. To provide the lighter heavy ion beams, at energies acceptable for biological research and medical therapy, a 25 meter diameter rapid cycling alternating-gradient synchrotron is proposed. With this machine fully stripped ions from the Hilac with $M \leq 20$ can be accelerated to energies up to 500 MeV/nucleon. Details of the synchrotron design will closely follow those developed for the Omnitron and a prototype of the Omnitron accelerating resonator will be used. (auth)

28127 ISOCHRONOUS CYCLOTRON WITH TANDEM INJECTOR FOR HEAVY ION ACCELERATION. Martin, J. A. (Oak Ridge National Lab., Tenn.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 797-8(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Since about a year ago various possibilities for a new accelerator to satisfy the needs of our nuclear physics and nuclear chemistry research have been studied. The primary requirement is to accelerate very heavy ions to energies above the Coulomb barrier of the heaviest elements, but an almost equally strong requirement is to provide light ions with energies of several hundred MeV. Single and multi-stage cyclotrons and a cyclotron with tandem Van de Graaff injector were reviewed to find the system that best satisfied the new needs of the Laboratory's various research programs. It was concluded that the best system for existing purposes consists of an isochronous cyclotron with a Model TU Tandem Van de Graaff accelerator as the injector. This plan is an extension of an already existing plan of the Laboratory to acquire a TU tandem with appropriate research facilities. The tandem-cyclotron combination will make it possible to accelerate the heaviest ions to energies of 7.5 MeV/amu and the lighter particles to hundreds of MeV. (auth)

28128 APPLICATION OF THE TANDEM TO HEAVY ION ACCELERATION. Rose, P. H. (High Voltage Engineering Corp., Burlington, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 799-801(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The design characteristics of tandem Van de Graaff accelerators for acceleration of heavy ions are discussed. Three stripper configurations are examined to determine how they effect the terminal voltage necessary to reach a given energy. To achieve higher energies it is shown how the tandem accelerator can be used as an injector to a second dc accelerator. (B.G.D.)

28129 ION SOURCES FOR HIGHLY CHARGED HEAVY IONS. Levy, Richard H. (Avco-Everett Research Lab., Everett, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 802 (June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Brief comments are presented on available ion sources for highly charged heavy ions. Emphasis is placed on the HIPAC source. (B.G.D.)

28130 ISOCHRONOUS HEAVY ION CYCLOTRON OF JINR. Shelaev, I. A.; Kozlov, S. I.; Oganesyan, R. Ts.; Oganesyan, Yu. Ts. (Joint Inst. for Nuclear Research, Dubna, USSR). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 802-3 (June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The design characteristics and operating parameters of the 2-m isochronous cyclotron at JINR are presented. (B.G.D.)

28131 TANDETRON HEAVY-ION ACCELERATOR. Purser, K. H. (Univ. of Rochester, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 804(June 1969).
From Particle Accelerator Conference, Washington, D. C.
See CONF-690308.

The advantages and capabilities of a heavy-ion cyclotron using a tanden Van de Graaff injector for nuclear studies are briefly discussed. (W.H.K.)

28132 HEAVY-ION CHARGE-CHANGE ACCELERATOR. Hortig, Gunter (Max-Planck-Inst. for Nuclear Physics, Heidelberg). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 804(June 1969).
From Particle Accelerator Conference, Washington, D. C.
See CONF-690308.

Plans for development of a heavy ion charge-change accelerator are briefly discussed. (W.H.K.)

28133 COMPUTERS IN ACCELERATOR CONTROL ROOMS: A PERSONAL APPRAISAL. Barton, M. Q. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 810-12(June 1969).
From Particle Accelerator Conference, Washington, D. C.
See CONF-690308.

Several synchrotron laboratories now use digital computers to monitor many accelerator performance parameters. Closed orbit shapes, for example, are now available in a few pulses. Experiments have also been performed on using computers for closed loop adjustment of critical accelerator parameters. The implication of these possibilities toward the next generation of accelerators is discussed. The requirements on computer hardware and supporting staff for implementation of a useful program are also discussed. (auth)

28134 BEAM DETECTION USING RESIDUAL GAS IONIZATION. De Luca, W. H. (Argonne National Lab., Ill.) IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 813-22(June 1969).
From Particle Accelerator Conference, Washington, D. C.
See CONF-690308.

The nondestructive beam detector systems originated at Argonne National Laboratory allow continuous measurement of the proton beam position and beam profile in the Zero Gradient Synchrotron during the accelerating and targeting cycle. Nondestructive detection is accomplished by collecting the ions produced by the proton beam ionizing residual gas in the vacuum chamber. The amplitude of the electrical currents obtained by collecting these ions onto a variety of electrodes depends on the distribution of the protons in the beam. The characteristics of the electric signals make them suitable as inputs to computer systems. Both analog and digital techniques have been used to determine beam position and profile. These beam detection systems have been used for measuring the properties of the 50-MeV beam between the injector linac and the synchrotron ring, for studying the steering and radial growth of the size of the beam during acceleration, and for measurements during the targeting sequences. (auth)

28135 ON-LINE COMPUTER MONITORING AND OPTIMIZATION OF A MULTIPLE TARGET PROTON BEAM LINE. Hornstra, F. Jr.; Knott, M.; Swoboda, C.; Bresica, A. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 823-6(June 1969).
From Particle Accelerator Conference, Washington, D. C.
See CONF-690308.

Operation, tuning, and monitoring of the multiple target EPB at the Zero Gradient Synchrotron (ZGS) is described. Instrumentation presently installed permits continuous, nondestructive, quantitative, on-line computer monitoring of beam spot size, position, and intensity at each experimenter's target or any desired location. The capability of a rapid emittance measurement is also provided. This measurement serves as input to computer programs, described elsewhere, which calculate the emittance and the necessary quadrupole settings for required beam profiles along the beam line. As a check, the resulting beam profiles are instantly measurable at appropriate locations and any necessary final adjustments to provide more exact required conditions are then accomplished. (auth)

28136 CAPABILITIES AND USES OF A GRAPHIC DISPLAY SYSTEM AS AN INTERFACE BETWEEN THE ZGS COMPUTER AND THE HUMAN OPERATOR. Lewis, L. G.; Knott, M. J.; George, R.; Chien, C. S.; Valente, A.; Gunderson, G. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 827-31(June 1969).
From Particle Accelerator Conference, Washington, D. C.
See CONF-690308.

The control computer system at the Zero Gradient Synchrotron (ZGS) contains a 20-in. cathode-ray graphic display system that can generate points, vectors, and characters. A variety of software routines have been written to operate the ZGS monitor on-line to obtain the required data, to perform the necessary calculations and to generate the specific display patterns. Two dimensional displays describe accelerator parameters that are functions of time, or of a space coordinate, or of a second machine parameter such as ring magnet field. Three dimensional displays (isometric), such as tune as a function of radial position and of ring magnet field, can also be generated. Many of the display patterns can be updated promptly so that the operator can follow the changes during an adjustment or optimization procedure. Experience shows that this display system can present complex information to the ZGS operator in a form that is easily understood. Permanent records of display information can be made by photography, by using the 30-in. X-Y plotter system, and by using the line printer. A variety of examples are discussed. (auth)

28137 INSTRUMENTATION AND CONTROL OF AGS SLOW EXTERNAL BEAM. Fox, J. D.; Bennett, G. W.; Levine, G. S.; Nawrocky, R. J.; Repeta, L. E.; Soukas, A. V. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 832-6(June 1969).
From Particle Accelerator Conference, Washington, D. C.
See CONF-690308.

Instrumentation for the slow external beam includes counter telescopes, insulated plates, spill counters, Cherenkov counters, fluorescent screens viewed by television cameras, and secondary emission chambers. Counter telescopes and directional Cherenkov counters are used to measure scraping of the beam at critical places. The over-all radiation background has been sufficiently low so that counter telescopes have been operated without jamming and without any evidence of loss of sensitivity due to radiation damage. Beam profiles have been measured by accurately positioned insulated fingers and by radioautographs of irradiated foils. Time structure of the beam is measured by spill counters and by insulated plates. Signal from a pair of insulated plates is used to generate a correction field in a ferrite core steering magnet to counteract angular beam modulation caused by momentum spread and ripple in the ejection magnet. Intensity is measured by secondary emission chambers which are calibrated against polyethylene foil activation; the calibration has remained reasonably constant over a wide range of beam intensities. (auth)

28138 USE OF COMPUTER DEVELOPED AND GENERATED DISPLAYS IN THE MONITORING AND CONTROL OF ACCELERATORS. Frankel, R. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 837-9(June 1969).
From Particle Accelerator Conference, Washington, D. C.
See CONF-690308.

At the AGS, our PDP-8 computer system possesses the ability to perform simple calculations in essentially real-time and to immediately present this normalized or processed information to the accelerator operator in either numerical or graphical form. Graphical information is displayed in a flicker-free manner on any standard oscilloscope by employing the computer's interrupt facility and a digital/analog converter. Alpha-numeric data or nontime dependent functions are readily presented with a software character generator data set, two digital/analog converters and an xy storage oscilloscope. Thus, special character generator sets or high cost cathode ray tube display systems are not required to provide the benefits of more sophisticated presentations of operational parameters. The system has been used to present such complicated and diverse displays as the frequency distribution of intensity, a quality control plot (including range limits) of accelerator efficiency, the accelerator's equilibrium orbit, and the pulse-to-pulse ejection efficiency of our slow extracted beam. (auth)

28139 IMPROVING INFORMATION EXCHANGE BETWEEN THE AGS AND ITS EXPERIMENTERS. Watts, A. R.; Cornish, G. W. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 840-3(June 1969).
From Particle Accelerator Conference, Washington, D. C.
See CONF-690308.

The increasing number of concurrently operating experiments and our expanding experiment areas are creating a need for more effective communications between the AGS and its users. With regard for cost, flexibility, and our often very noisy environment, a visual information network has been devised to complement our public address, experiment hall status-board, and interphone communications system. A closed circuit television system and associated annunciator panel are used to provide each experimental group with machine status, performance data, and other information of interest. Each experimenter sends coded operational status information to the control room where it is processed and displayed. Relevant machine and experimenters' information is at the same time sent to our computer which periodically scans and records this information so that it may be analyzed and presented on command. The details of this network are described, and our criteria for selecting information to be transferred in this manner is discussed. (auth)

28140 COMPUTER CONTROLLED ENERGY SPREAD MEASUREMENT AT THE CERN PS LINAC. Kracht, U.; van der Schueren, A.; Tallgren, U.; Tetu, P. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 844-7(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

A new method of energy spread measurement is described which permits a quick evaluation of the percentage of the PS linac beam inside the acceptance range of energy spread for the synchrotron. The execution of the measurement, for which a minimum of two beam pulses are lost, is under control of the PS Control Computer, IBM 1800, and makes use of two beam slits, a triplet lens, and a beam deflecting magnet. The result of the measurement is simply obtained as the ratio of two beam current transformer readings. These are read in the beginning and at the end of the beam pulse and the computed results together with other Linac machine parameter readings of interest, such as rf tank levels, are displayed on a TV-screen at the linac and in the PS Main Control Room. On request, a print-out of the results can also be obtained. Before executing the measurement, the computer program checks the status and levels of important parameters and in case of malfunctioning warns the operator with a diagnostic message on the TV-screen. (auth)

28141 BEAM MATCHING, STEERING, AND DESIGN USING A CDC-924, AND OSCILLOSCOPE, AND PROGRAMS DEVELOPED AT ARGONNE NATIONAL LABORATORY. Marcowitz, Stewart; Concaildi, George; George, Richard (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 848-51(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Computer programs have been developed at ANL to match given input beam phase space conditions to desired output conditions with up to six quadrupoles. An oscilloscope will produce beam envelopes, trace rays, or produce phase space diagrams at given locations in a much larger simulated beam system. Provisions are available for treating off-axis and off-momentum beams. Elements include slits, drift space, quadrupoles, and bending magnets. The phase space configuration accepted by a system with displaced elements, off-momentum beams, asymmetrically placed slits, and element apertures can be displayed on the oscilloscope. These features have been used to design experimental beams, tune the Zero Gradient Synchrotron (ZGS) external proton beam, and steer the ZGS external proton beam. Excellent agreement has been found between the program predictions and actual beam parameters. Measurements of beam spot sizes at one or more locations have been used to compute beam phase space conditions which are subsequently used in the other programs. The programs used have been titled WIEMNY, MATCH, and QUISP. (auth)

28142 DIGITAL RESONANCE CONTROL SYSTEM FOR THE DRIFT-TUBE LINAC. Sharp, John B.; Swain, George R. (Los Alamos Scientific Lab., N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 852-4(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

A resonance control system for the drift-tube linac portion of LAMPF has been proposed; it incorporates a digital computer in the closed loop. The inherent computational capabilities of the digital computer allow considerable flexibility in the digital controller. Nonlinear functions of various feedback variables and their derivatives, which are easily implemented on the computer, can improve the steady-state and step responses of the system. The long thermal time constants in the system make conventional compensation techniques hard to implement with analog circuitry, but relatively simple with digital software. An experimental resonance control system for a 4-ft drift-tube linac model has closed the loop through an SEL-810A computer. The model has separate water-cooling systems for the tank wall and the drift tubes. The necessary state variables from each system are fed back into the digital controller, which generates from this data the number of pulses necessary to drive valve-positioning stepping motors, thereby regulating the amount of cooling water entering the system. This setup also allows a study of the effects on the control system of a longer drift tube tank by inserting into the software appropriate time delays. (auth)

28143 STIMULATION AND MEASUREMENT OF RADIAL BETATRON OSCILLATIONS IN THE BEVATRON USING THE rf ACCELERATING SYSTEM. Crebbin, K. C.; Lothrop, F. H. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 855-6(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Recent activity in resonant extraction of the circulating proton beam at the Bevatron spurred interest in accurately measuring the radial betatron-oscillation frequency. A discussion of the techniques and hardware employed in the project is presented. Calculations indicated that it would be practical to use the existing rf system tuned to the betatron oscillation frequency for excitation of the desired oscillations. In practice, the measurement is made during a period of constant magnetic field, when the accelerating rf may be turned off and the beam allowed to coast at a constant radius. The frequency is changed to the betatron frequency, and the rf system is turned on again. The proton rotational frequency and the betatron oscillation frequency were measured with the aid of a small digital data processor. The system allows dynamic, on-line, presentation of beam radius, betatron frequency, and rotational frequency to a precision of about one part in 10,000. (auth)

28144 CONTROLS FOR THE CERN INTERSECTING STORAGE RINGS. Groebner, O.; Neet, D.; Rieben, P.; Sagnell, B.; Schaffer, G.; Scholl, R.; Unser, K.; Wolstenholme, P. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 857-61(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The requirements and present work on the design and construction of the control system for the CERN Intersecting Storage Rings (ISR) are summarized. Details are presented of the controls for the various beam transfer channels required to link the CERN Proton Synchrotron to the ISR and to a new beam switchyard and experiment area for use of fast or slow ejected beams. The factors which dominate the layout of the ISR control system are discussed; the function and design of major parts, such as beam transfer instrumentation, vacuum controls, personnel radiation protection and the control computer system are described. (auth)

28145 SLAC ACCELERATOR CONTROL COMPUTER. Reagan, Daryl (Stanford Linear Accelerator Center, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 862-3(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

A digital computer system is being installed in the SLAC accelerator control building to assist the operators who monitor and control the accelerator proper. Initially, the computer will be programmed to recognize losses of klystrons, which result usually from temporary malfunctions, and in each case to select and switch on a suitably programmed replacement unit. As more equipment is installed and programs are developed, the computer will take on a variety of jobs. It will prepare and analyze records of accelerator system and component performance. It will assist in setting up new experiments. It will perform control operations where rapid response is desirable. It is planned that the computer will eventually form part of a system in which all accelerator and beam switchyard controls are manipulated from one control center. (auth)

28146 THE PROCESS CONTROL COMPUTER AT THE CERN PROTON SYNCHROTRON: ITS APPLICATION IN THE OPERATION OF A FAST EJECTED BEAM. van der Beken, H.; Machen, D. R.; Madsen, J. H. B.; Serre, Ch. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 864-5 (June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

In 1966 the decision was made to acquire an IBM 1800 for assisting, and possibly optimizing, the operation of the PS. Computer applications that involved acquisition as well as control settings were begun. An existing system for remote control of dc power supplies for the ejected beam transport was easily adapted to the computer requirements (control via a frequency multiplexed system). The following tasks are performed by the computer for the fast ejected beam: to measure and to keep the currents in the beam transport elements constant; to furnish a log on the ejected beam, store a reference log and provide, on request, a variation log; and to search for the beam position on the external target that gives a maximum secondary particle production. This task is done via a scanning and optimizing program which displays the progress of the procedure visually on a CRT. Details on the operational features, the hardware and the software are provided, together with illustrations on the results obtained. (auth)

28147 DIGITAL CONTROL OF BEVATRON EXTERNAL-PROTON-BEAM TRANSPORT MAGNETS. Evans, Don (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 866-70(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

A computer-based, digitally structured, data acquisition and control system has been developed for the purposes of on-line programmed control of external beam transport magnets at the Bevatron. The control algorithm achieves flexibility to accommodate all possible modes of Bevatron operation by separating the operating cycle of the accelerator into several zones. This method allows independent processing of Bevatron field within each zone, and the introduction of zone-related time-variable functions in each of the magnet currents. Evolution of the hardware is discussed, together with consideration of employing small computers for each well-defined project, over a time-shared single large computer. The technique utilized to provide time-sharing of peripheral hardware between small computers is described. Pertinent details of methods used to achieve noise rejection in data transmission, both analog and digital, are examined. Communication between digital systems and human operator is discussed in terms of minimizing the number of operator responses required to establish a series of functions to be performed by the system. (auth)

28148 ZERO GRADIENT SYNCHROTRON EXPERIMENTAL AREA COMPUTER CONTROL SYSTEM. Hoffman, Earl W.; Marcato, Paolo; Nordey, David H.; Parslow, Leroy G.; Schweingruber, Frank L. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 871-2(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

A control system has been installed in the experimental area at the Zero Gradient Synchrotron. It is presently being used to monitor and control the magnets and other beam line components in the separated beam lines to the hydrogen/deuterium and Freon/propane bubble chambers. This has made possible the reassignment of control room personnel and the more efficient operation of the bubble chambers. Equipment is being added to extend the control capability to other beam lines and buildings in the experiment area. Facilities are also being added to allow the system to act as a source of information for analysis of experimental data through both computer interconnection and tape storage. The system is operated in a foreground/background mode so that all experimental beam line monitoring and control operations are fully protected from operator error. This allowed the system to be useful to the physics program within a month after the computer delivery while also allowing the assembling and checkout of more advanced programs. (auth)

28149 COMPUTER-CONTROL FOR THE MARYLAND CYCLOTRON. Etter, J.; Jenkins, K.; Nelson, D. (Univ. of Maryland, College Park). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 873-4(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The Isochronous Cyclotron at the University of Maryland has been designed to allow computer control of all machine operations in a manner that permits unique operational flexibility. Digital control lines, 16 bits wide, run from various devices in the laboratory to a central multiplexor unit. From there, they are routed to either the operator's console or to a computer data bus. The data bus is attached to a small control computer which will be interfaced to an on-line IBM 360/44, and will be capable of reading and setting machine controls as well as communicating with the machine operator. The software of the control computer will consist of a highly simplified time sharing system which will coordinate the execution of several independent software modules called "tasks." Each task will pertain to a particular control function and the operating system will "time share" among several tasks, allowing them to run concurrently. It is intended that this system will greatly simplify normal operations and allow the operator greater freedom from menial chores. (auth)

28150 OMNIBUS: A MULTI-PROGRAMMING EXECUTIVE SYSTEM FOR THE ZERO GRADIENT SYNCHROTRON CONTROL COMPUTER. Knott, M.; Brescia, A.; Valente, A. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 875-9(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

As the digital computer undergoes increasing utilization as an on-line evaluation and feedback control device for an accelerator, it becomes necessary to provide it with a multi-programming executive software system. The system should be capable of accommodating several on-line control functions simultaneously so that these functions can be developed and utilized independently. The system should also provide for general-purpose off-line utilization such as new program development to proceed simultaneously with and unimpeded by the continuous operation of the accelerator. OMNIBUS, the multi-programming executive system now in use with the Zero Gradient Synchrotron control computer facility, incorporates these features and several others not found in commercially available multi-programming systems. OMNIBUS obtains data for the various programs from locations and at times requested by the programs and also provides the control link either by modifying the program stored in the timing system of the synchrotron or by direct transmission of timing pulses or digital information to the accelerator. The system also provides for operator modification of the various programs and communications with them without interrupting their on-line control or monitoring functions. (auth)

28151 REAL-TIME EXECUTIVE FOR A SMALL COMPUTER SYSTEM. Stewart, C. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 880-2 (June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

A PDP-8 system, consisting of two processors, a disk, a tape drive, and numerous devices interfacing with the AGS, has access requirements running from microsecond real-time to input/output jobs which may run for fifteen minutes. An executive is described which allows programs to time-share the processors on a 16 millisecond exchange-jump basis. This executive also supervises time-sharing of a resident utility system package which is also described. Two job stacks are provided—one calls resident programs at preselected millisecond intervals, and the other services an 8-exchange-point list of time-shared programs. A disk is used for general purpose, input/output, and for program library service. Programs may be called from this disk library via programs running in the PDP-8 or from the on-line teletype. A floating-point arithmetic package is available and shares core with other programs by means of a rollin/rollout facility. (auth)

28152 COMPACT DATA ACQUISITION AND CONTROL TERMINAL FOR PARTICLE ACCELERATORS. Machen, D. R.; Gore, R. A.; Weber, D. W. (Los Alamos Scientific Lab., N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 883-6 (June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The present trend toward automation of information processing in particle accelerators dictates the need for a thorough evaluation of the method used in collection and dissemination of this information. A compact, remote terminal for use in automatic data acquisition and control of particle accelerators is described. The terminal may be controlled either by special-purpose digital logic or by a central control computer. Interfacing to the various accelerator equipment is provided through analog and on-off control and monitoring modules. The detailed design of the logical portion of the remote terminal, in regard to data format, instruction, and command decoding, is discussed. The method of selection of the appropriate module interface for completion of the desired function is also treated. In addition, the equipment-interfacing design criteria resulting from actual implementation on accelerator devices are discussed. Finally, a report is made on the operating experience gained through use of the remote terminal interfaced to a high intensity proton source. (auth)

28153 PCM DATA TRANSMISSION SYSTEM USING SPLIT PHASE CODE. Budge, Ezra C. (Los Alamos Scientific Lab., N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 887-90(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The LAMPF control system specifies transmission of both data and timing signals between the control room and the local control points throughout the machine for data collection and equipment control information. A balanced system is used to reduce noise pickup. The transmitter receives a timing pulse train and the digital data in a "non return to zero" NRZ format. The two signals are combined to form a split phase code and transformer coupled to the transmission line. The receiver uses a minimum energy content circuit (integrator) preceding the decoder to reduce noise sensitivity. The number of timing pulses in the incoming pulse train is known, as is the time duration of the transmission. This information is used to further reduce the probability of error. Parity checking is also provided. The system is described and results of experiments on the system reported. (auth)

28154 MULTIPLEXING DIGITIZED BEAM INFORMATION FOR ACCELERATOR USERS AND OPERATORS. Greeley, F.; Knott, M.; Lewis, L.; Swoboda, C.; Toussaint, F. Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 891-3(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

As the list of digital data signals required by accelerator users grows, it becomes more economical to use serial-input parallel-output multiplexers at the users control station than to increase the number of coaxial cables used to supply parallel data. Increasingly, on-line computers are used to control and monitor accelerators, and since the digital beam data are naturally generated in a serial mode, the multiplex receiver becomes doubly desirable. The Zero-Gradient Synchrotron (ZGS) at ANL has built such a receiver named CUPID, an acronym for CompUted Pulse Information Decoder. Using two lines of serial input, the receiver generates one counter master reset pulse and input signals for up to thirty-one counters. The paper includes block diagrams, system description, and practical application data. (auth)

28155 APPLICATION OF TELEPHONE CROSSBAR RELAYS TO COMPUTER CONTROL OF A PARTICLE ACCELERATOR. Davis, James W.; Dexter, Warren L.; Smith, Bob H. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 894-7(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

A prototype automatic control system using crossbar relays for switching was built for experimental study. Eleven sets of these highly reliable and inexpensive relays can provide computer or manual access to the control of 10,000 magnets or other regulated systems. The system consists of a computer, several manual-control panels, a set of crossbar relays, digital regulator references and actuating devices, and a corresponding readback system. The manual-control panels contain an address keyboard, which controls the crossbars, and a data-entry keyboard. The data are routed to the desired regulator reference or actuator. Since any number of manual-control panels may be used, each maintenance specialty can have its own control of the accelerator on "down" days. For automatic operation the computer simply replaces one of the manual-control panels. The coil-to-contact isolation in the regulator reference chassis and digital read-out systems provide essentially infinite noise isolation between the accelerator and the control system. Without the computer the cost is comparable to a conventional manual-control system. Design considerations of the special devices which are unique to this type of control are included. (auth)

28156 AUTOMATED MULTIPLE-BEAM CHARGED-PARTICLE TRANSPORT SYSTEM. Dexter, Warren L. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 898-900(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

A novel automated magnet switching system has been devised whereby power for beam-transport magnets of multiple-beam arrays can be supplied by common power supplies, thereby reducing the power-supply costs to that of a single beam line. The heart of the system is compact and inexpensive computer- or punched-card-operated reversing and selector switches that can switch kilo-amperes. The complete system and the switches are described in detail. (auth)

28157 ION SOURCE CONTROL THROUGH HIGH VOLTAGE ISOLATION DISTANCES UTILIZING PHOTON-COUPLED SOLID STATE DEVICES. Bennett, Robert L. (Univ. of Wisconsin, Madison). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 901-2(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Low power photon-coupled semiconductors may be utilized to control a pulsed ion source operating at a high potential isolated from ground. If efficient optical coupling is achieved, a distance capable of standing off as much as a megavolt may be possible. Various methods of optical coupling may be used, such as lens or mirror focusing or by transportation of the light beam through an optical fiber bundle. The latter method is presently being used in a system designed for Dr. C. D. Curtis at NAL. The isolation distance for this ion source system will stand off 150 kV. Operation of the ion source at this distance has been satisfactory. Preliminary tests indicate that the isolation distance may be doubled with no deterioration in performance merely by increasing the optical fiber bundle length. Minor circuit modifications, including a slightly higher power level light-emitting semiconductor diode and an appropriately longer optical fiber bundle, should extend the potential isolation distance to the 1-MV goal. The semiconductor light source is a pn junction gallium arsenide light-emitting diode. The light detector is a NPN planar silicon phototransistor. (auth)

28158 LINEAR LIGHT LINK DATA TRANSMISSION. Budge, Ezra C. (Los Alamos Scientific Lab., N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 903-4(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Reference is made to a digital data transmission system presented earlier. Many signals from the ion source in the high voltage head will be digitized and transmitted via a light link to the control point. However, wide bandwidth signals are difficult to digitize, transmit, and reproduce; therefore, a linear transmission system using light links to cross the high voltage interface has been developed. The transmitter and receiver were aligned in the usual laboratory environment. A triangular waveform was used to test linearity and a fast rising pulse was achieved at a distance of 40 ft between transmitter and receiver. The system is described and results of experiments with the system reported. (auth)

28159 THE MEASUREMENT OF AGS SPATIAL BEAM DENSITY DISTRIBUTIONS BY MEANS OF FLIPPING TARGETS. Vogel, U. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 905-8(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

A development of the technique of monitoring the spill off targets sweeping across the AGS proton beam is presented. To achieve minimum interference with the beam and adequate accuracy, stems of 20-mil beryllium wire have to be swept across the beam within milliseconds. This was achieved by mounting an inertial linkage mechanism on a standard target motor. The mechanism links two beryllium wire stems so that they sweep the beam in mutually perpendicular paths. Two orthogonal beam profiles are thus generated. The sweeping speed is obtained from high angular velocities of the wire stems. Due to the dynamics of the linkage arrangement, the above velocities are several times higher than the angular velocities of the standard target motor. A description of the above and results of tests made on the bench and in the AGS ring are presented and discussed. (auth)

28160 THE CPS GAS-IONIZATION BEAM SCANNER. Johnson, C. D.; Thorndahl, L. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 909-13(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

A non-destructive beam scanner was installed in the CPS ring early in 1968. Deriving a signal from the electrons liberated by the proton beam from the residual gas in the vacuum chamber, and using a crossed electric and magnetic fields system of electron collection, the scanner gives the projected proton density distributions in the horizontal and vertical planes. Spatial resolution is better than 1 mm. An important feature is the use of a single collector which receives electrons from a slice of the beam close to the zero equipotential surface. The electric equipotential surfaces are parallel to the proton beam axis and scanning is achieved by displacing these equipotentials laterally in the region of the beam. In particular, the zero equipotential, which always passes through the detector, is scanned right through the beam. Trials at scanning frequencies up to 5 kHz and pressure around 2.10^{-6} Torr (nitrogen equivalent) have yielded some interesting results. A double beam is seen under certain conditions on the flat top at 19 GeV/c. Another application is to the study of beam dimensions during the first few ms after injection. Further refinements include the installation of an electron multiplier to permit a lower pressure limit and an increased scanning rate, around 1 MHz, revealing coherent beam envelope oscillations. (auth)

28161 BEAM PROFILE MONITORS FOR FAST AND SLOW EXTRACTED PROTON BEAMS. Neet, D. A. G. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 914-18(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Two types of beam profile monitors, based on the principle of secondary emission (SEM), and some work on beam observation screens made of inorganic material are described. They will be used for emittance measurements, for beam matching, and in general for adjusting the beam transfer system of the CERN-Intersecting Storage Rings. The first type SEM profile monitor consists of a grid of 15 horizontal and 15 vertical narrow foils, which together with the necessary electronics provide quantitative signals on the beam intensity profile. The second type consists of two SEM probes, driven by stepping motors. Each probe is programmed either to find the horizontal and vertical edges of the beam, or to make a plot of the intensity distribution. Also, inorganic luminescent beam observation screens are described which are suitable for ultra-high vacuum. (auth)

28162 DYNAMIC BEAM PROFILE MEASUREMENTS UTILIZING SYNCHROTRON RADIATION. Ebeling, W.; Bennett, G. W. (DESY, Hamburg). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 919-20(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

An instrument is described which images a section of the beam on a fluorescent screen using pin-hole optics and the short wavelength (<10 Å) part of the synchrotron radiation spectrum. The screen is viewed by a photomultiplier tube through a rotating-disk shutter. Radial and vertical beam profiles at various energies can be measured, on-line, with a resolution of 0.1 mm. (auth)

28163 BEAM MONITORING AT THE NBS LINAC: ENERGY, CURRENT, POSITION, CHARGE. Menke, John L. (National Bureau of Standards, Washington, D. C.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 921-2(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The beam monitoring systems at the NBS Linac are briefly reviewed. This includes a pulsed magnet for energy display with a 200 scanned-gate electronic system. Shielding and electronics for use with ferrite loaded position and current monitors are discussed, and the use of a fast, wide-range integrator with ferrite current pick-ups is outlined. (auth)

28164 EVALUATION OF HIGH STABILITY SECONDARY EMISSION MONITORS. DeParry, Theodore; Ratner, Lazarus, G. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 923-6(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

A description of a stable, remotely operated, high vacuum (10^{-8} torr), low scattering ($\theta = 0.246$ mrad) secondary emission monitor (SEM) system developed at ANL is given. A block diagram and important details of the electronic control circuits are shown. Performance characteristics of the SEM system covering the dynamic range of from 10^8 to 10^{13} protons/burst are given. With activation foils as reference standards, the experimental results of the secondary yield vs high energy primary protons are presented for the kinetic energy range of the primary protons of 4 to 12.5 GeV/c. Experimental and expected theoretical results are discussed. (auth)

28165 PICOSECOND BEAM MONITORS AND DATA ACQUISITION SYSTEM. Norris, N. J.; Hanst, R. K. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 927-31(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The 30-A, 50-ps electron pulse generated by the EG&G/AEC Linear Accelerator permits the measurement of scintillator response functions and the study of other subnanosecond phenomena. To take advantage of this capability a system for fast pulse monitoring has been developed. Faraday cups and non-intercepting monitors are designed to measure the electron beam current, and are used in conjunction with a unique data acquisition system for fast pulse measurements. This system uses the fastest available sampling oscilloscopes, modified for remote operation of the sampling elements, thus eliminating the signal distortion of the coaxial cable between the experimental measurement point and the data recording area. The digitized output of the sampling oscilloscope is stored and repeatedly averaged to increase the signal-to-noise ratio, allowing the measurement of signals that are about 100 ps in duration and a few millivolts in amplitude. The digital information, recorded on either magnetic or paper tape, is compatible with computerized data reduction techniques. This data acquisition system may be used on any recurring fast pulse and offers a sensitivity-bandwidth improvement of about 10^5 over the best traveling wave oscilloscopes. (auth)

28166 CALIBRATING INDUCTION ELECTRODES USING CATHODE RAY BEAMS. Simanton, James R. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 932-3(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

During the design phase and prior to installation in the Zero Gradient Synchrotron (ZGS) straight sections, beam induction electrode behavior was thoroughly investigated with several methods, including driven wire techniques, chopped Van de Graaff proton beams, and cathode ray guns. Results presented demonstrate that the latter method provides the most realistic and versatile means of simulating in-machine behavior. Subsequent operation in the ZGS has been commensurate with test behavior. The apparatus and technique used to calibrate electrodes at realistic frequencies without dependence upon the accuracy of RF instruments are described. Frequency, transient, and position response measurements are presented. Electrode design and the inherent superiority of electron beams relative to wire techniques for design evaluation are discussed. (auth)

28167 BEAM CURRENT TRANSFORMER WITH DC TO 200-MHz RANGE. Unser, K. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 934-8(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Methods of extending bandwidth, signal-to-noise ratio, and dynamic range in beam current monitors using large aperture (140 to 180 mm) toroid transformers are described. Three systems have been built— all feature nanoseconds rise time— but differ in complexity and low frequency cutoff. A single transformer device is used in the CERN Proton Synchrotron Linac. Operation close to the upper frequency limit (rise time 2 ns) is purely passive. An operational amplifier back-up loop extends the lower frequency limit to below 1 kHz. A dual toroid system is used in the CERN PS to measure the number of circulating protons with high precision. Separate high and low frequency channels combined in an active feedback loop yield a 30-ns rise time, together with an effective L/R time constant in excess of 4 hours. A triple toroid assembly will be used in the precision monitor for the CERN Intersecting Storage Rings. A magnetic modulator is combined with an active ac system to provide full frequency coverage down to dc. (auth)

28168 PULSE-SIGNAL VIEWING SYSTEM FOR ACCELERATORS. van Buren, Dale T.; Maddocks, Hugh C. (Los Alamos Scientific Lab., N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 939-40(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The operation of an accelerator requires that signals from various points about the machine be available for viewing in the control room. For the larger accelerators, the cable runs may be several thousand feet long. For such applications, a system is being developed with a 10% to 90% rise time of 80 nsec, overshoot of ≤0.5 dB, and a droop of less than 0.5% for a 1-msec pulse. The necessary pre-emphasis filters for each cable run are designed by a computer program. The computational procedure on which the program is based is described. A method for integrating the viewing system with a computer-based data acquisition and control system to provide for automatic switching is discussed. (auth)

28169 CRYOPUMPING THE OMNITRON ULTRA-VACUUM SYSTEM USING HEAT PIPES AND METALLIC CONDUCTORS. Milleron, N.; Wolgast, R. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 941-4(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The Omnitron is a synchrotron with a storage ring that will deliver beams of light and/or heavy ions at different energies and currents. Storage of heavy ions in a high-charge state for 25 ms requires that the vacuum be specified carefully. A conservatively crude figure of merit, $10^{14} \leq N \cdot \Sigma n_i Z_i^2$ is used where: $N = 3 \times 10^7$ turns around the accelerator, n_i = the concentration of atoms of the i^{th} atomic number Z_i. Cryopumping cold fingers are inserted in each gap between magnets for both the synchrotron and the storage ring (190 pumping stations). Each finger is cooled at one end by a distribution ring and consists of an 80°K jacket around a 4°K core. Several tests of one full-size pumping station comprising an alumina beam tube brazed to stainless steel are given with heat pipes and metallic heat conductors in the cold-finger design. This approach permits the finger temperature to be raised almost independently of the distribution temperature. The <7 hour pump down to the Omnitron figure of merit achieved, gives the pumpdown time for the whole machine. (auth)

28170 THE TITANIUM VACUUM CHAMBER FOR THE ZERO GRADIENT SYNCHROTRON. Hanson, Willard B. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 945-9(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

An all-metal, titanium alloy inner vacuum chamber has been built for the Zero Gradient Synchrotron (ZGS). This chamber has high radiation resistance, high mechanical strength and provides mountings for pole face windings. The upper and lower surfaces of the chamber consist of 0.012-in. titanium skins which span the 32-in. aperture along the 54-ft length of the octant. These skins are reinforced with radial T-shaped ribs $^3/_8$-in. high to withstand the design loading of 30 torr. The 20 miles of titanium ribs are diffusion bonded to the skins to provide high strength joints that cannot leak. Eddy current problems are minimized by using an alloy of high electrical resistivity. Pole face windings mounted in holes in the ribs will be used to correct for the effects of the residual eddy currents. Many of the new techniques that were developed for aerospace applications were used to produce and test this chamber. These techniques and the results of the tests are discussed. (auth)

28171 CORRUGATED-BELLOWS VACUUM CHAMBER FOR FAST-CYCLING SYNCHROTRONS. Avery, R. T.; Tidrick, G. A. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 950-1(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Historically, vacuum chambers for fast-cycling synchrotrons have been a problem, usually due to some combination of poor reliability, excessive outgassing, fragility, radiation damage, field distortion, and high cost. It is shown that corrugated metal bellows-type vacuum chambers of several meters length are an attractive alternative. Excellent vacuum characteristics are achieved at a fraction of the cost of ceramic chambers. Calculations indicate that the increased electrical resistance due to corrugating the walls reduces eddy currents such that heat dissipation and field distortions are not likely to be serious problems. Adequate structural strength can be achieved within dimensions comparable to those of ceramic vacuum chambers. Existing synchrotrons may benefit by retrofitting the described bellows-type chambers in place of existing chambers. (auth)

28172 ELLIPTICAL VACUUM CHAMBER STRESS AND DEFLECTIONS. Avery, R. T.; Tidrick, G. A. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 952-3(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Equations are derived for the bending moments and stresses at all points in a uniform wall tubular chamber of elliptical cross section subjected to uniform pressure loading. Equations are also derived for deflections at the major and minor axes. Graphs and tables are included to facilitate computations. This data can be used directly for analysis of elliptical vacuum chambers which are frequently used in synchrotrons and elsewhere. The method employed can be used for analysis of vacuum chambers with cross sections other than elliptical. (auth)

28173 TESTS OF A FAIL-SAFE VACUUM BEAM LINE USING ACOUSTIC DELAY AND A FAST CLOSING VALVE. Wolgast, R. C.; Davis, J. W. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 954-5(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The fail-safe line is equipped with a McClure switch pressure rise detector, a labyrinth acoustic delay section, and an eddy-current driven fast closing valve. The line is representative of an injection or target beam line for the Omnitron, and is needed to protect the ultra-high vacuum system against sudden rupture of the vacuum envelope and the associated contamination. The valve closes a 1-in. dia. bore in less than 1 ms with 500 J in the power supply capacitors. The acoustic delay section (2 ft. long) delays the pressure rise by 4 ms. In simulated vacuum failures 11 ft. from the valve, without the delay section, less than 10^{-5} torr-liters of air (the sensitivity limit of the instrumentation) passed through the valve. The addition of an in-line liquid nitrogen trap and a residual gas analyzer will permit examination of the protected system for contamination. (auth)

28174 PROPOSED HIGH CURRENT BOOSTER SYNCHROTRON FOR THE PRINCETON–PENNSYLVANIA ACCELERATOR. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 956-8(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

A 75-MeV strong-focusing A. G. proton synchrotron has been proposed as part of a new injector system into PPA. Such a booster would increase the 3 GeV intensity of PPA to 10^{12} protons per pulse or 2×10^{13} protons per second. Following is a design description of this proposed 3 to 75 MeV booster synchrotron. (auth)

28175 THE CERN PROTON SYNCHROTRON BOOSTER. Reich, K. H. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 959-61(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The main features of this 800 MeV injector are described. The design philosophy is discussed. (auth)

28176 GENERAL CONSIDERATIONS ON BOOSTER INJECTORS. Courant, E. D. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 962 (June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The various types of booster synchrotrons for beam injection in multi-GeV proton synchrotrons are reviewed. Their relative advantages and disadvantages are discussed. (B.G.D.)

28177 SOME CRUCIAL PROBLEMS IN THE DESIGN OF THE 300 GeV SYNCHROTRON. Hardt, W. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 963-4(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Some of the problems encountered in the design of the booster for the 300-GeV synchrotron are briefly examined. These are lattice structure, beam extraction, radius of the main ring, space charge effects, induced radioactivity, beam correction facilities, vacuum systems, and mechanically tuned rf cavities. (B.G.D.)

28178 SYSTEMATICS OF BOOSTER INJECTORS. Peterson, J. M. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 965(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The systematics of booster injectors are illustrated by an intercomparison of the principal parameters of the booster synchrotrons that have been presented at this conference. The systematics are: (1) If the main ring charge per pulse is close to a space charge limit of about 10^{13} or greater, it should be divided among several booster pulses. This subdivision can be accomplished by subdivision in time (as in the fast booster) or in space (as in the multiple-ring booster). (2) If the main ring charge per pulse is about 10^{12} or less, there is no need to subdivide the charge, so that the booster can be a single ring cycling at the same rate as the main ring (slow booster). (B.G.D.)

28179 DESIGN OF THE NAL BOOSTER. Billinge, R.; Snowdon, S. C.; van Steenbergen, A. (National Accelerator Lab., Batavia, Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 969-74(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The design of the 10-GeV injector synchrotron for the NAL 200-GeV machine includes many interesting features. These have developed over a period of about one year, during which time many alternative approaches were considered. The magnets were designed using analytical computations to design pole contours whose effectiveness was subsequently determined both by finite permeability computations and field measurements. The concept of modular construction of the synchrotron ring as utilized at the Cornell 10-GeV machine has been incorporated in the definitive design. (auth)

28180 BEAM DYNAMICS PROBLEMS IN A MULTIPARTICLE RAPID CYCLING SYNCHROTRON. Selph, Frank B. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 975-8(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The proposed Omnitron facility includes a synchrotron that will accelerate protons to 1.4 GeV and heavier elements to tens of MeV per nucleon. To obtain intense high energy beams of the heavier elements, after the first acceleration cycle the beam is placed in a storage ring, then on the next cycle is stripped, reinjected, and accelerated to hundreds of MeV per nucleon. As the particle species delivered by the injector is changed a range of e/m values from 0.05 to 1 must be accepted, and the intensity can change by orders of magnitude. Problems that arise in injection, bunching, acceleration, extraction, and reinjection are discussed. Provisions for beam handling and control must be flexible enough to allow maximum possible exploitation of the accelerator facility. Possibilities for time-shared utilization of the machine are considered. For this to be most effective, each experimenter must be able to specify particle species and energy independently. It is also necessary to make a rapid change-over from one set of operating conditions to another. This sets requirements for reproducibility, for rapid tuning, and for fast troubleshooting. (auth)

28181 PROGRESS ON THE GERMAN PROTON-SYNCHROTRON. Arendt, F.; Erb, J.; Heinz, W.; Juengst, K.-P.; Rudloff, W.; Siegmund, U.; Steinbock, L. (Kernforschungszentrum, Karlsruhe, Ger.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 979-84(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Last year the Karlsruhe group proposed a proton synchrotron of 40 GeV and 10^{12} p/s in the extracted beam. The design has been reconsidered both with respect to lattice (separated function), and injection scheme. For about 20% of the total capital cost of the machine it is possible to increase the intensity to 10^{13} p/p at 40 GeV, or to keep the 10^{12} p/s and increase the energy to about 60 GeV, or to install both these options. As a new version the last of these alternatives is proposed. Parameters of this improved machine are given; the different stages of approach are discussed. (auth)

28182 DESIGN OF A 600-MeV SUPERCONDUCTING MICROTRON. Sutton, D. C.; Hanson, A. O.; Jamnik, D.; Robinson, C. S.; Axel, P. (Univ. of Illinois, Urbana). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 985-91(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The design of a 600-MeV racetrack microtron proposed for the University of Illinois is discussed. It consists of a 30-MeV superconducting linac operating at 1.3 GHz between two uniform field bending magnets about 7 meters apart. There will be 19 parallel return paths separated by 14.7 cm. Vertical focusing is provided on each return orbit by a quadrupole pair close to each magnet. For quadrupoles 20 cm long and separated by 10 cm, the gradients required to advance the vertical oscillation phase by 90° per revolution increase monotonically from 0.1 to 0.5 kilogauss per centimeter. Only very weak horizontal focusing powers are needed to keep the return beams within 2 mm of the linac axis. The linac itself provides some focusing and two weak quadrupole singlets on the linac axis, one near each magnet, provide additional focusing. A number of tests with single superconducting lead and niobium cavities are continuing in order to find a satisfactory method of fabricating and operating a superconducting accelerating section. (auth)

28183 STRONG FOCUSING MICROTRON. Aucouturier, J.; Leboutet, H. (Compagnie Generale de Telegraphie Sans Fil, Corbeville, France). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 992-3(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Whether the accelerator section used in the race track microtron is superconducting or not, focusing of the beam to avoid any interception is a fundamental requirement. Furthermore, since this kind of machine is likely to be able to develop very large average powers, some care in the adjustment of the beam is required. To achieve that, it is necessary that each orbit should be stable for betatron oscillations (excluding eventually resonances). One way of achieving that is to go to a triangular geometry (3 symmetry). It is then shown that this geometry permits a good orbit separation, separate orbit control, and ease of outgassing the accelerator waveguide, even of bigger dimension to allow operation at 450 MHz. (auth)

28184 SOME CONSTRUCTION DETAILS FOR SUPERCONDUCTING MAGNETS FOR FFAG ACCELERATORS. Kruger, P. Gerald; Snyder, J. N. (Univ. of Illinois, Urbana). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 994-9(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Previous calculations on superconducting FFAG accelerators are refined and extended so that detailed Nb_3-Sn coil configuration can be described. These are given for a 1-GeV model accelerator. The same general principles are extended for use in calculating fields from Nb_3-Sn coil configurations for an FFAG accelerator in the energy range of 2000 to 3000 GeV. Relative cost estimates for an FFAG versus pulsed accelerators are given for some critical components of superconducting and/or cryogenic accelerators. Advantages and disadvantages of pulsed versus FFAG accelerators are discussed. (auth)

28185 REPORT ON THE PERFORMANCE OF THE SUPERCONDUCTING INJECTOR FOR THE STANFORD LINEAR ACCELERATOR. Jones, E.; McAshan, M. S.; Suelzle, L. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 1000-3(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Some recent experiments performed with a prototype of the injector section eventually to be used in conjunction with the superconducting linear accelerator at Stanford University are described. (auth)

28186 FEASIBILITY OF A TWO-MILE SUPERCONDUCTING LINAC. Herrmannsfeldt, W. B.; Hogg, H. A.; Loew, G. A.; Neal, R. B. (Stanford Linear Accelerator Center, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 1004-8(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Assuming that investigations now underway will result in superconducting accelerator structures capable of withstanding gradients of 10 MeV/foot, a feasibility study of a two-mile 100-GeV superconducting electron linac with 6% duty cycle has been made at frequencies of 1428 and 2856 MHz. Tentative machine parameters and the preliminary design of components and systems are examined. These studies are based upon a traveling-wave accelerator structure with rf feedback in each 40-ft. section. (auth)

28187 RF SUPERCONDUCTING MATERIALS RESEARCH AT SLAC. Allen, M. A.; Cobb, J. K.; Dean, N.; Farkas, Z. D.; Garwin, E. L., Hogg, H. A.; Hoyt, E. W.; McConnell, R. A.; Rabinowitz, M.; Roder, A. (Stanford Linear Accelerator Center, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 1009-12(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Progress of the materials research program is described. The program objectives are to evaluate materials and develop processing and fabrication techniques which it will be economically feasible to use in the construction of a high-gradient (10 MeV/foot) two-mile linear accelerator. RF properties are evaluated by cavity Q measurements at selected frequencies in the range 3 to 11 GHz. Techniques for reducing field emission are being sought. At present, this phenomenon is being studied by making dc measurements at room temperature. RF superconducting properties are known to be very sensitive functions of material purity and crystal structure. For this reason, various methods of deposition, surface purification, and heat treatment are being tried. Most work is being done with lead and niobium, but technetium plating is being actively investigated. (auth)

28188 INVESTIGATION OF SUPERCONDUCTING NIOBIUM CAVITIES AT S-BAND. Hahn, H.; Halama, H. J. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 1013-17(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Pure lead, niobium, and technetium are the elemental materials which exhibit properties suitable for superconducting rf devices such as linear accelerators or rf beam separators. Considerable experimental information is presently available for lead, whereas relevant results for niobium were obtained at X-band frequencies only. An investigation of superconducting Nb cavities at S-band frequencies (2.87 GHz) is presented. The TE_{011} and TM_{011} cavities were machined by Varian Associates from solid billets of electron-beam-melted niobium and then chemically polished to remove all work-damaged material. We found that the intrinsic quality factor of Nb cavities is at equal temperature about 1.4 × Q of Pb. The niobium TE_{011} cavity has a Q_0 (4.2°K) $\approx 325 \times 10^6$ and a residual $Q_{res} \approx 7 \times 10^9$, whereas the TM_{011} cavity has a Q_0 (4.2°K) $\approx 89 \times 10^6$ and a residual $Q_{res} \approx 392 \times 10^6$. Power measurements in the TM_{011} cavity were limited by multifactoring. (auth)

28189 MEASUREMENTS OF THE RF-ABSORPTION OF SUPERCONDUCTING RESONATORS. Flecher, P.; Halbritter, J.; Hitschold, R.; Kneisel, P.; Kuehn, W.; List, L.; Stoltz, O.; Szesci, L. (Univ., Karlsruhe, Ger.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 1018-22(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The measured surface resistance R of superconductors deviates remarkably from theoretical prediction of the BCS-theory R_{BCS} at low temperatures and high field levels. At low temperatures the residual surface resistance R_{Res} is large compared with the surface resistance in the frame of the BCS-theory. The reason for this is not well understood at present. Therefore, measurements are performed on the dependence of R_{Res} on frequency and on electric or magnetic field amplitude. At higher temperatures and low rf-field amplitudes the measured and calculated surface resistance agrees. At high field levels however the measurements indicate deviations from the BCS-theory, especially if there is a rf-electric field perpendicular to the surface. To clarify these deviations experiments were undertaken. The dependence of the absorption on the shape and on the depositions (galvanizing or evaporizing) is also studied. (auth)

28190 BEAM CAVITY INTERACTIONS IN A SUPERCONDUCTING PROTON ACCELERATOR STRUCTURE. Kuntze, M.; Mittag, K.; Vetter, J. (Univ., Karlsruhe, Ger.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 1023-6(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

In an electron experiment the properties of a superconducting structure for a proton linear accelerator at 760 MHz were studied. The experimental setup offers the possibility to investigate beam loading effects, which are expected to severely effect the dynamical behaviour of a superconducting proton linear accelerator. Simultaneously, the electron experiment delivers several independent methods of determining the superconducting shunt impedance. First results of beam-cavity interactions at He-temperature were obtained in a one-meter accelerator model. Narrow electron bunches are decelerated in the self-induced fields with no rf-power fed to the superconducting structure. A rf-power proportional to the square of the chopped current was measured outside the cavity. From these measurements a value for the shunt impedance can be deduced that is in agreement with the Z-value obtained from continuous beam measurements. With rf-power fed to the structure, measurements under heavy beam loading are going on and the excitation of higher modes is studied. (auth)

28191 TRANSIENT BEAM LOADING IN ELECTRON LINEAR ACCELERATORS. Leiss, J. E.; Penner, S.; Rose, J. E.; Broberg, J. B. (National Bureau of Standards, Washington, D. C.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 1027-30 (June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Most theories of the transient behavior of linear electron accelerators do not include dispersive effects or the additional beam loading due to excitation of various space harmonics in the waveguide. Attempts to include dispersive effects in calculations have yielded conflicting predictions. There is great interest in this subject because of the implications to very high energy electron ring accelerators. An experiment to measure these effects has been devised by sending a well analyzed and bunched electron beam through either an unexcited accelerator waveguide or a vacuum pipe. Electron energy loss due to beam loading in the waveguide is detected by measuring the shift in energy of elastically scattered electrons with the NBS electron scattering spectrometer. Energy shifts of a few parts in 10^5 can be measured. Preliminary measurements at 60 MeV and for beam pulse lengths of 5, 10, and 20 ns appear to be in agreement with references 1 and 2 when both dispersive effects and space-harmonic excitation are included. For 5-ns rectangular beam pulses a sixteen-fold increase in beam loading is predicted over calculations that do not include these effects. Since the energy shifts observed are small, possible systematic errors in the experiment are being examined. It is planned to extend the measurements to shorter electron beam pulses and to different electron energies. (auth)

28192 EXCITATION OF A CLOSED CYLINDRICAL CAVITY BY A CHARGED RING MOVING ALONG THE AXIS AT CONSTANT VELOCITY. Levine, B. S.; Sessler, A. M. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 1031-3(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

An important aspect of the design of high-current devices is the beam loading of the accelerating structure. The phenomenon is sensitive to the charge distribution of the beam and to the geometry of the structure. Calculations for realistic geometry are difficult; to gain insight, a number of authors have studied the simplified problem of beam interaction with a closed, right cylindrical cavity. A formal solution, for arbitrary charge distribution, has been given as a (double) sum over the modes of the cavity. It has been emphasized by all previous workers that the simplified problem approximates reality only for those modes having wavelengths large compared to the holes in an actual structure. A computational program which evaluates the formal expression for cavity excitation was developed. Sums over selected sets (or all) modes are available. A cylindrical beam pulse is characterized by its length and inner and outer radii. Parametric studies are presented of the total cavity excitation by a charged ring. (auth)

28193 METHOD FOR STATIC-FIELD COMPRESSION IN AN ELECTRON-RING ACCELERATOR. Laslett, L. J.; Sessler, A. M. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 1034-8(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

In the original proposal of Veksler et al., the electron ring of an electron-ring accelerator (ERA) is compressed by a pulsed field from a large to a small radius and with an associated increase of electron energy. Compression can be achieved (without an energy gain) in a static magnetic field. With acceleration divorced from the compression function, the need for large supplies of pulsed power is avoided, and increased repetition rates become possible — at the expense of a higher-energy injector. Static-field compression can be achieved without the use of alternating sections of axial acceleration and deceleration. A means for static-field compression without axial acceleration is described, and examples are given of the field configurations and coil arrangements that are required. It is proposed that axial focusing can be maintained with this arrangement through the provision of a small traveling magnetic well that serves to convey the ring through the compressor. (auth)

28194 COLLECTIVE ION ACCELERATION AT VERY HIGH ENERGY IN A STATIC MAGNETIC FIELD. Christofilos, Nicholas C. (Univ. of California, Livermore). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 1039-42(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Extremely relativistic electrons injected in a static magnetic field form a ring that can subsequently be compressed by a sequence of axial acceleration and deceleration, as previously reported. Ions trapped in the electrostatic field of the electron ring can in principle be accelerated in a decreasing magnetic field to very high energy. The electrons in the ring are confined by an external magnetic field. Radial stability of the trapped ions is provided by imposing an azimuthal momentum on the ions equal and opposite to the electron azimuthal momentum so that both ions and electrons are magnetically focused by the external magnetic field. The ions are initially accelerated by adiabatic expansion of the ring in a decreasing magnetic field; subsequently the ring is decelerated at constant radius. During this step the ions acquire an azimuthal mechanical momentum almost equal to that of the relativistic electrons. The azimuthal momentum of the ions and electrons are subsequently equalized by allowing the electrons to lose energy by synchrotron radiation. Preliminary parameters of a static magnetic field 1000-GeV ion accelerator are presented. (auth)

28195 THEORETICAL STUDIES ON THE FORMATION OF A COMPRESSED 25-MeV ELECTRON RING IN A STATIC MAGNETIC FIELD. Berg, R.; Kim, H.; Nelson, D.; Reiser, M. (Univ. of Maryland, College Park). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 1043-6(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

In the proposed electron-ring accelerator schemes that are presently under study the ring is formed by injecting a 4.5-MeV electron beam into a solenoidal field and subsequently compressing it adiabatically to the desired diameter of about 7 cm and an energy of about 23 MeV. After being loaded with positive ions the ring is either injected into a linear accelerator or ion acceleration is accomplished by simple expansion in the magnetic fringe field. The expansion process was investigated with a computer program called HELIX which integrates the relativistic equations of motion in three dimensions. Magnetic field data can be used in either analytical form or as an array of data points. The effects of initial conditions (energy spread, width and divergence) on the beam structure during expansion have been studied and are compared with the adiabatic theory. The possibility of forming an electron ring by nonadiabatic axial injection of a 23-MeV beam into a solenoidal field was also investigated. (auth)

28196 FLAT-TOPPING MAGNET CURRENT FOR THE BERKELEY ELECTRON-RING-ACCELERATOR EXPERIMENT. Baker, William R.; Gagnon, William L.; Voelker, Ferdinand (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 1047-9(June 1969).
From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The Berkeley electron ring accelerator experiment requires that several time-sequenced magnetic fields be generated to compress the injected electron ring from a radius of 25 cm to a radius of 3.8 cm. It is necessary to hold the electron ring at 3.8 cm radius for several milliseconds to study radiation and gas ionization effects in the compressed ring. This is done by flat-topping the current in a short-time-constant magnet to within 3% for 3.0 msec. The magnet current is pulsed to an initial value of 27,000 A by a capacitor bank and series ignitron switch. A solid-state diode clamps the current at this value; the current then begins to decay at a rate determined by circuit losses. The flat-top circuit adds enough energy to compensate for the average I^2R losses. This is accomplished by sequentially discharging capacitors into a transformer, the secondary of which is connected to the 30,000-ampere magnet circuit through a solid-state diode bridge. Simple design equations are developed which are applicable for flat-topping similar magnets. Also discussed are some of the critical aspects of the design. (auth)

28197 MECHANICAL DESIGN OF COMPRESSOR TEST APPARATUS FOR ELECTRON RING ACCELERATOR RESEARCH. Avery, R. T.; Hernandez, H. P.; Reimers, R. M.; Salsig, W. W. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 1050-4(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The concept of accelerating a dynamically stable fraction of heavy ions in a fast-turning ring of electrons opens a new dimension for particle accelerator design. Apparatus to investigate injection, compression, and ion loading of very high current electron rings has been constructed and operated at LRL. Design and hardware features of the apparatus are presented. The intense beam of electrons is obtained from Project Sherwood's Astron. The beam channel to the ERA compressor must select the brightest fraction, pass only a few nanoseconds of the 250-ns 400-A Astron pulse, and provide a transition from ordinary to ultra high vacuum. Sequential excitation of three coil pairs creates a magnetic mirror bottle in the compressor. The magnetic field at the electron ring rises from near zero to 20 kG in about 700 μs. Because of this rapidly changing field a ceramic vacuum chamber is used, and an epoxy-fiberglass laminate structure resists the 5-ton dynamic load from the coils. Design studies of a contemplated apparatus to investigate ion-loaded electron rings during extraction from the magnetic bottle and subsequent magnetic acceleration are discussed. (auth)

28198 MEASUREMENT AND OPTIMIZATION OF THE EMITTANCE OF A 300-ns, 250-A, 3.4-MeV ELECTRON BEAM. Allison, R. W. Jr.; Beal, J. W.; Everette, W. L.; (and others) (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 1055-8(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The two-dimensional emittance of the 3.4-MeV, 250-A electron beam produced by the Astron linear induction accelerator has been measured. The measurement utilized a slit plate and a glass slide. A densitometer scan of the slit pattern formed on the glass by irradiation was analyzed and emittance contours drawn. Substitution of a radiation-resistant Mn-activated Al_2O_3 scintillator permitted observation of the slit pattern of each pulse by using television. This equipment allowed the induction accelerator to be tuned for minimum emittance without excessive beam loss. Ninety percent of the beam was within a phase-plane area of 0.17 cm-radians. Data on the two-dimensional phase-space density are also presented. (auth)

28199 FAST BEAM CHOPPERS FOR THE ELECTRON-RING ACCELERATOR. Faltens, Andris; Kerns, Cordon. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 1059-60(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Two beam choppers were constructed which produce a 20-ns nearly square pulse of 3 + MeV electrons out of the best portion of the 300-ns Astron beam, or an 8-μs microwave electron linac beam for injection into the ERA compressor. The choppers are impedance matched traveling-wave devices that deflect the beam with equal strength electric and magnetic forces, and are powered with either 3 electrode spark gaps or thyratrons and a 20-ns pulse line. The electron beam is biased out of the beam transport system with a dc magnetic field and pulsed into it with the chopper. (auth)

28200 THE FIXED-FIELD, ROTATING-MAGNET SYNCHROTRON OR: WHY PULSE? Good, M. L. (State Univ. of New York, Stony Brook). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 1061-4(June 1969).

A scheme is presented whereby dc superconducting magnets may be used to make up an ultra-high energy AGS. The necessary time variation of guide and focusing fields is achieved by slowly rotating dipole and quadrupole elements about the beam axis. The plan is not impractical in any obvious way. Power requirements are those of the rf, plus Dewar losses; no ring magnet power supply is needed. (auth)

28201 A POLARIZED PHOTON BEAM FOR THE SLAC 82-INCH HYDROGEN BUBBLE CHAMBER. Sinclair, Charles K. (Tufts, Univ., Medford, Mass.); Murray, Joseph J.; Klein, Paul R.; Rabin, Monroe IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 1065-8(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

A highly polarized beam of high energy photons has been produced at the Stanford Linear Accelerator by Compton backscattering ruby laser quanta from a high energy electron beam. Photon energies from 1.4 to 5.9 GeV are obtained by varying the electron energy from 8 to 18 GeV. Intensities are more than adequate for bubble chamber exposures. Monochromatization to a few percent, dependent on the peak photon energy, is achieved by limiting the electron beam phase space and collimating the scattered photon beam. Average polarization, also dependent on the peak photon energy, exceeds 90%. Any state of circular or linear polarization is selectable on a programmed pulse-to-pulse basis. The only backgrounds, from synchrotron radiation and residual gas bremsstrahlung, are completely eliminated by a combination of soft magnetic fields, collimation, a thin uranium absorber (0.01 X_0), and high vacua as required. Details of the beam design, and measurements of its characteristics are presented, along with techniques for further improvement in energy, intensity, and resolution. (auth)

28202 A LASER INDUCED COMPTON BACK-SCATTERED PHOTON BEAM AT THE CAMBRIDGE ELECTRON ACCELERATOR. Sauer, Jon R. (Tufts Univ., Medford, Mass.); Milburn, Richard H.; Sinclair, Charles K.; Fotino, Mircea. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 1069-72(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

At the CEA, a 20 joule per pulse normal mode ruby laser is being used in an attempt to produce a highly polarized hard photon beam of intensity suitable for high energy physics experiments. The measured energy spectrum of these Compton back-scattered photons and the yield of about 40 quanta per laser joule per mA of accelerated electron beam are in reasonable accord with theoretical expectations. It was demonstrated that Compton scattering of a laser beam is a suitable non-destructive probe of extreme relativistic charged particle beams by measuring the spatial density of the CEA internal beam in the horizontal plane, as well as its variation with machine energy, orbit perturbations, and time during the acceleration cycle. It appears possible to determine the parameters of the beam phase-space ellipses, making a complete description of ultra-relativistic beams accessible to the laser beam probe technique. Attention is called to the possible application of this technique to storage ring beams, particularly in the crossing regions where other methods of beam monitoring are difficult. (auth)

28203 ELECTRON POSITRON STORAGE RINGS: STATUS AND PRESENT LIMITATIONS. Amman, Fernando (CNEN, Frascati, Italy). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 1073-81(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The current status of electron and positron storage rings is reviewed. The experimental results on beam instabilities, their consequences on the design of a high current storage ring, and the technological problems involved are discussed. (auth)

28204 SUPERCONDUCTING SYNCHROTRONS. Green, Michael A. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 1082-91(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Superconductivity has advanced considerably since the discovery of high field type II superconductors in 1961. During the last two years superconductivity has at last become a tool of high energy physics. One may now consider the construction of a superconducting proton synchrotron. Several laboratories in the United States and Europe are studying the feasibility of superconducting synchrotrons. A realistic look at such a synchrotron requires a study of the machine components and their interaction, and a study of the fundamental properties of such a machine. Economics will be the prominent reason for ultimately building such a machine. Since the magnet system is the primary difference between superconducting and conventional machines, it is emphasized. There is a short discussion of magnet coil configurations, superconducting materials, and the use of iron as a magnetic shield and return path. The magnet system also consists of a power supply, cryostats, and a refrigeration system. All of the components are discussed in some detail. The use of superconducting synchrotron magnets permits one to consider a number of alternative solutions to rf, vacuum, and injection-extraction problems. Changes in the enclosure and other conventional facilities for a superconducting machine are discussed. A rough cost estimate of superconducting synchrotrons is presented. The effect of field, beam intensity, and repetition rate on cost is discussed. In conclusion, it is shown that a superconducting synchrotron is both feasible and economical. (auth)

28205 STRUCTURES FOR SUPERCONDUCTING ELECTRON LINACS AND RF SEPARATORS. Wilson, P. B. (CERN, Geneva). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 1092-1103(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

The problems involved in the design of suitable structures for superconducting electron linacs or for superconducting rf separators are similar in many ways. Some basic principles are developed which apply to the design of structures for both devices. In optimizing superconducting structures, the emphasis is different than for conventional structures. The gradient in a superconducting structure is limited by effects depending on the peak electric and magnetic fields at the superconducting surface. It is of primary importance, therefore, to reduce these peak fields as much as possible relative to the average gradient, even if some shunt impedance must be sacrificed. The designs of various standing-wave structures, such as π-mode and bi-periodic structures, are considered from this point of view. However, the structure that gives the highest gradient for a given peak field is the traveling-wave resonator. This type of resonator is treated in some detail, since its behavior is less familiar and somewhat more complex than is the case of standing-wave resonators. In particular, the matching of such a resonator must be accomplished with great precision or substantial power will flow in the reverse direction. Other factors that enter into the design of superconducting structures, such as tuning, coupling, and thermal and mechanical stability, are also considered. (auth)

28206 REFRIGERATION FOR SUPERCONDUCTING AND CRYOGENIC SYSTEMS. Strobridge, T. R. (National Bureau of Standards, Boulder, Colo.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 1104-8(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Cryogenics and high energy physics have been intimately associated for many years. The liquid hydrogen bubble chamber remains a primary detector for particle interactions, and the recent successful development and superconducting rf cavities will vastly improve the duty cycle of linear accelerators. Aside from target and detection devices, it is not clear what role low temperature environments will play in the particle accelerators now being conceived. The amount of cooling required and the refrigeration temperatures may vary widely from concept to concept. To assist in planning, this survey of modern cryogenic refrigerators, covering refrigeration temperatures from about 1.8 to 80°K, gathers together performance, physical characteristic, and typical cost information from industry, academic, and government sources both in the U. S. and abroad. Whenever possible, data on liquefiers are converted to an equivalent refrigeration capacity. The capacities discussed range from about one watt to kilowatts. The last minute status of the newest low temperature facilities is summarized. (auth)

28207 ACCELERATOR POWER SYSTEMS. Green, G. K. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci., NS-16: 1109-20(June 1969).

From Particle Accelerator Conference, Washington, D. C. See CONF-690308.

Accelerator facilities use large amounts of power and convert most of this power to frequencies and voltages quite different from those of the incoming lines. High energy facilities now tend to require much more power for their experimental programs than they do for the accelerator proper. Power conversion is being influenced by the development of solid state devices. One can begin to anticipate radically different approaches to solid state conversion and to control with digital techniques. It is also probable that the power characteristics of experimental areas will undergo drastic revision as cryogenic magnets are introduced for beam transport and spectrometers. (auth)

28208 TWO-BEAM OPERATION OF THE 1.5 GeV ELECTRON–POSITRON STORAGE RING ADONE. Amman, F.; Andreani, R.; Bassetti, M. (and others) (CNEN, Frascati, Italy). Nuovo Cim., Lett., 1: 729-37(May 21, 1969).

The first results of two-beam operation of the Adone electron-position storage ring are reported. Measurements of the luminosity were performed observing the interaction rate of e^+e^- single bremsstrahlung and e^+e^- scattering at small angles; the luminosity was also computed from beam currents and transverse dimensions. A luminosity of $(3.4 \pm 0.4) \cdot 10^{32}$ cm^2 h^{-1} was obtained at 1.1 GeV with 40 mA of positrons and 23 mA of electrons in head-on collision. The results show that with 100 mA beams a luminosity higher than the design value should be obtained. (L.B.S.)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 26214, 26613, 27705, 28066, 28304, 28600, 28601, and 28614–28618.

28209 (AE-351) A DETERMINATION OF THE 2200 m/s ABSORPTION CROSS SECTION AND RESONANCE INTEGRAL OF ARSENIC BY PILE OSCILLATOR TECHNIQUE. Sokolowski, E. K.; Bladh, R. (Aktiebolaget Atomenergi, Stockholm (Sweden)). Feb. 1969. 14p. Dep.

Pile oscillator measurements of heavy-water solutions of As, B, Mn, and In have been carried out in two different neutron spectra in the R0 reactor. For B, Mn, and In the 2200 m/s cross section values recommended in BNL-325 are given to within 1.5% or less, while for As the stated uncertainty is 5%. In the present work the BNL values for B, Mn and In were used to derive weighted mean calibration constants for the reactor, which were then in turn used for obtaining self-consistent cross section values for all four elements. The values thus obtained for B, Mn and In were within experimental error of the recommended BNL values. The absorption cross section for As is in good agreement with a recently published value for the activation cross section. The value for the resonance integral of As, derived from the present measurements, is in better agreement with calculations from resonance parameters than values reported earlier. (auth)

28210 (CTH-RF-16) DETERMINATION OF NEUTRON DECAY CONSTANTS USING SIMULTANEOUS PULSE HEIGHT AND TIME ANALYSIS. Grosshoeg, Gudmar (Chalmers Tekniska Hogskola, Goteborg (Sweden). Institutionen for Reaktorfysik). Dec. 1968. 51p. Dep.

A series of experiments was made to solve the problem of higher modes and background in determination of fundamental decay constants with pulsed neutrons. A 150 keV SAMES neutron source was used together with a rotating cylindrical moderator composed of up to 8 polyethylene discs of 2.2 cm thickness and a dia of 18 cm. The moderator was placed in an Al box and shielded with B_4C. Three detectors were placed outside the moderator: the first and third one at positions where the second mode of the cylindrical function was zero and the second moderator at the maximum point of the fundamental mode. (Sweden)

28211 (GA-9036) INTEGRAL NEUTRON THERMALIZATION. Annual Summary Report, October 1, 1967–September 30, 1968. Beyster, J. R.; Borgonovi, G. M.; Gozani, T.; Houston, D. H.; Koppel, J. U.; Naliboff, Y. D.; Neill, J. M.; Slaggie, E. L.; Sprevak, D.; Young, J. C. (Gulf General Atomic, Inc., San Diego, Calif.). Oct. 30, 1968. Contract AT(04-3)-167. 94p. Dep. CFSTI.

Work carried out on the Integral Neutron Thermalization Program of Gulf General Atomic, Inc. in the period Oct. 1, 1967 to Sept. 30, 1968 is described. The studies included neutron thermalization in light and heavy water, diphenyl, polyethylene, beryllium, beryllium oxide, uranium dicarbide, uranium dioxide, and zirconium hydride as well as spectral studies in ^{235}U and ^{238}U spheres. (J.W.R.)

28212 (IKF-22) SCATTERING OF THERMAL NEUTRONS ON SINGLE CRYSTALS OF ICE. Daubert, J.; Jex, H.; Rossberg, D. Frankfurt Univ. (West Germany). Institut fuer Kernphysik). Nov. 1968. 48p. (In German). Dep.

The total neutron cross sections $\sigma_{tot}(E_0)$ of water, polycrystalline ice and single crystals of ice in the energy range from 2 MeV to 1 eV were determined by neutron transmission measurements. Especially the dependence of the cross sections on the orientation of the single crystals was investigated and is qualitatively interpreted. (auth)

28213 (JINR-P14-4355) COHERENT SCATTERING OF SLOW NEUTRONS BY LIQUID LEAD. Golikov, V. V.; Kozlov, Zh. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1969. 38p. (In Russian). Dep.

The results of the measurements of the slow neutron coherent scattering by solid and liquid lead in a wide range of momentum transfers performed on the installations at the pulsed reactor IBR by the time-of-flight method are reported. The data obtained indicate that two types of collective excitations characterized by dispersion relations analogous to the rules of the dispersion of the crystal longitudinal and transversal oscillations are present in liquid lead. The experimental results are compared with the polycrystal liquid model and with the hydrodynamic model, which takes account of the dependence of kinetic coefficient on frequency. The limits of the applicability of these models are discussed. (auth)

28214 (TID-25050) A TECHNICAL AND ECONOMIC EVALUATION OF NEUTRON SOURCES FOR THERMAL NEUTRON RADIOGRAPHY. Krolick, Cyril F.; Katerndahl, Dean; Voll, Ronald (AUA-ANL Summer Engineering Practice School, Argonne, Ill.). Aug. 2, 1968. 62p. Dep. CFSTI.

A technical and economic analysis of a variety of nonreactor neutron sources for thermal neutron radiography applications is presented. Included also is a listing of the characteristics of thermal nuclear reactors which have been used for neutron radiography. The study shows that at the present time, there are no neutron sources which can provide the quantities of neutrons that are available from reactors. The development of spontaneous fissioning isotopes, however, and sealed-tube neutron generators may provide very attractive sources in certain circumstances. Also, for continuous fluxes, where slightly less intensity than that available from a reactor can be utilized, a 1 to 3 MeV Van de Graaff utilizing the deuterium-beryllium reaction appears attractive. (auth)

28215 (UCRL-50570) NEUTRON AIR TRANSPORT CALCULATIONS. Webster, Walter M. (California Univ., Livermore. Lawrence Radiation Lab.). Jan. 8, 1969. 70p. Dep. CFSTI.

A series of Monte Carlo neutron air transport calculations was conducted for an isotropic, point neutron source in an homogeneous atmosphere. Twelve monoenergetic source energies ranging from 10 keV up to 14.1 MeV were investigated. The spatial and energy distribution of the transported neutrons was obtained out to a penetration depth of 160 g/cm^2. The transported neutron fluence was recorded in 28 energy groups between 0.025 eV and 14.6 MeV. The fluence in each of the 28 tally groups from each source energy calculation is described by a polynomial equation in the range from the neutron source. The coefficients which were obtained by the least squares method are given in tabular form. (auth)

28216 TIME MODULATION OF A NEUTRON BEAM DIFFRACTED ON A SINGLE QUARTZ CRYSTAL EXCITED INTO VIBRATIONS BY HIGH FREQUENCY PULSES. Michalec, R. (Nuclear Research Inst., Rez, Czech.); Chalupa, B.; Galociova, D.; Mikula, P. Phys. Lett., 28A: 546-7(Jan. 27, 1969).

Measurements are presented proving the time modulation of a neutron beam by a single quartz crystal put into vibrations by means of a high-frequency pulse with a duration of 100 μs, 500 μs, 1000 μs, 2000 μs, and 4000 μs. (auth)

28217 HALF-SPACE MULTIGROUP TRANSPORT THEORY IN PLANE GEOMETRY. Shultis, John Kenneth. Ann Arbor, Mich., Univ. of Michigan, 1968. 137p.

Thesis.

Exact solutions to the isotropic multigroup neutron transport equation for various half-space problems in plane-geometry were obtained. These solutions are obtained by combining the techniques of Chandrasekhar's principle of invariance and Case's singular eigenfunctions expansion, and extending them to the multigroup case. The main advantage of the present method over previous half-space techniques is that it is less complicated and numerical evaluation, particularly for emergent distributions, is far simpler. The albedo problem is found to be of fundamental importance for half-space problems, since the solutions of all the other problems can be expressed in terms of the albedo solution. The albedo problem is solved in two distinct steps. First the emergent distribution is calculated. By considering a singular eigenfunction expansion for the albedo problem, an inhomogeneous Fredholm equation for this emergent distribution is obtained. This equation is, however, difficult to evaluate numerically since it involves computation of the N-group eigenfunctions. By using Chandrasekhar's invariance principle, a nonlinear integral equation for the emergent distribution can be obtained. This equation is easily solved by numerical iteration. Once this emergent distribution is known, the known full-range completeness and orthogonality relations of the eigenfunctions are used to obtain the angular flux inside the half-space. From the albedo problem solution, the solutions of the other half-space problems are obtained. As an example, a computer code has been developed which gives the emergent distribution to the Milne problem and its extrapolation length for any number of energy groups. Finally for the special case of a symmetric transfer matrix (as is found in thermal neutron transport problems, and certain radiative transfer cases) it is shown how the results for a general transfer matrix can be greatly simplified. For this case, uniqueness of solution of the Fredholm equation, reality of the eigenvalues of the transport equation, and half-range completeness of the eigenfunctions can be easily proven. (Disser. Abstr.)

28218 NEUTRON INCOHERENT SCATTERING FROM KDP. Steinman, D. K.; Summerfield, G. C. (Univ. of Michigan, Ann Arbor). J. Phys. Chem. Solids, 30: 449-51(Feb. 1969).

The incoherent, inelastic neutron cross section is derived for KH_2PO_4 following the model discussed by Tokunaga and Matsubara (1966). This expression should give the dominant contribution of the proton tunneling motion to the cross section. Matsubara gave the coherent cross section for KDP. The scattering in hydrogen, however, is primarily incoherent. (auth) (UK)

28219 METHOD OF CALCULATING THE NEUTRON SCATTERING LAW OF ASYMMETRIC TOP MOLECULE. I. GENERAL THEORY. Sekiya, Tamotsu. Technol. Rep. Osaka Univ., 18: 309-15(Oct. 1968).

The neutron scattering law for a rotating asymmetric-top molecule was calculated. Not only was Volkin's quantum mechanical expression rewritten into a systematized form which enables numerical evaluation, but also a method of statistical average over all possible J and an iterative method to increase the order of correction were developed. The wave function of the asymmetric-top molecule has expanded by the set of eigenfunctions of the symmetric-top molecule by reducing the Hamiltonian tensor into symmetric matrices. Using an expansion of the delta function whose argument is the sum of two operators into a series of derivatives of delta function about one of the arguments, one can also take into account the effect of translational degree of freedom. The results suggest that the singularity included in the scattering law for rotating molecule may be softened by the superposition of translational motion. (auth)

28220 ADJUSTED VALUE OF EFFECTIVE WIDTH FOR H_2O AND D_2O. Mori, Nobuo; Tsuchihashi, Keiichiro (Japan Atomic Energy Research Inst., Tokyo). J. Nucl. Sci. Tech. (Tokyo), 6: 155(Mar. 1969).

The effective width in the scattering model for H_2O and D_2O was adjusted so that the theoretical neutron diffusion coefficient in the lattice is equal to the experimental value. Other parameters were only slightly affected by the adjustment. (J.W.R.)

28221 RELATIONSHIPS BETWEEN NEUTRON WAVES AND SOUND WAVES. Williams, M. M. R. (Queen Mary Coll., London). J. Phys., D (London), 2: 389-400(Mar. 1969).

The basic equations of neutron-wave and sound-wave propagation are deduced by appealing directly to the nonlinear Boltzmann transport equation. The approximations inherent in these linear equations are pointed out, and the properties of the respective neutron and gas-atom scattering kernels are elucidated. The low-frequency behavior of both types of wave is studied, and explanations are given for the small attenuation coefficient of sound waves as compared with neutron waves of the same frequency. The source boundary conditions are discussed, and certain approximate conditions are suggested for the sound-wave problem that may reduce the mathematical complications. The effect on the dispersion law of finite transverse dimensions is explored in some detail. It is found that although a dispersion law does not exist for neutron waves in a sufficiently small system, such a law does exist for sound waves. The frequency range over which it exists, however, becomes smaller as the transverse dimensions become smaller. (auth)

28222 THEORY OF PULSED NEUTRON EXPERIMENTS IN POLYCRYSTALLINE MODERATORS. Conn, Robert William. Pasadena, Calif., California Inst. of Tech., 1968. 156p.

Thesis.

A theoretical investigation was made of pulsed neutron experiments in thermal, nonmultiplying, polycrystalline moderators. A transport approximation was used to model the spatial dependence of the neutron distribution function. The initial value problem for the Boltzmann equation describing the decay of thermal neutrons in a finite, polycrystalline system was studied. The scattering kernel employed contains an isotropic, square-integrable component describing inelastic scattering and a term of the form $v\Sigma_{el}(v)\delta(v'^2-v^2)$ that models elastic scattering. Laplace transform methods were applied to the Boltzmann equation which lead to an unsuspected structure in the transform variable plane. Discrete eigenvalue existence theorems were re-examined and the role of new continuum terms in the total solution were considered. The variation of the lowest eigenvalue with system size, i.e., the dispersion law, was thoroughly investigated. An alternate representation of the dispersion law was developed which aids in explaining experimental results. A simplified model of the inelastic scattering kernel was used to investigate and expand the ideas and to examine the role of various continuum contributions to the total solution. The dispersion law was examined in some detail both analytically and numerically. Comparisons were made with experimental data and multi-group calculations in beryllium and graphite. (Diss. Abstr.)

28223 NEUTRON ATTENUATION IN WATER AND ALUMINUM–WATER MIXTURES. Coulbourn, George Irvin Jr. Charlottesville, Va., Univ. of Virginia, 1968. 195p.

Thesis.

The fast neutron spectrum was measured at various distances from a point fission neutron source in water and in two aluminum and water mixtures using seven threshold reaction detectors. Also determined was the attenuation of the fast neutron dose rate and the thermal neutron flux. The experimental results were compared with calculations made using the ANISN computer code. The threshold reactions used were the $^{115}In(n,n')$, $^{32}S(n,p)$, $^{64}Zn(n,p)$, $^{27}Al(n,p)$, $^{56}Fe(n,p)$, $^{24}Mg(n,p)$ and $^{27}Al(n,\alpha)$. Using experimentally determined counting efficiencies, absolute saturation activities of the threshold reaction products were determined. A method of fast neutron spectrum unfolding was devised which represented the fast neutron spectrum by a group of successive exponentials, calculated from the saturation activities. The reported spectra generally agreed well with the results predicted by the ANISN code. The fast neutron dose rate was measured directly using p-i-n junction dosimeters and indirectly by applying flux-to-dose conversion factors to the measured fast neutron flux. Good agreement was obtained between these measurements and calculations. The saturation activities from the $^{32}S(n,p)$ reaction were compared with the measured and calculated dose rates and an activity to dose rate conversion factor estimated, allowing this reaction to be used for integral dose measurements. (Diss. Abstr.)

28224 NEUTRON TRANSPORT THEORY WITH A COMPLETELY DEGENERATE ENERGY TRANSFER KERNEL. Watts, James Fred. Blacksburg, Va., Virginia Polytechnic Inst., 1968. 123p.

Thesis.

An analytic solution of the time-dependent neutron transport equation in slab geometry was found for a completely degenerate energy transfer kernel and a 1/v total cross section. The time dependence was removed from the transport equation by a Laplace transformation and the solution of the homogeneous form of the transformed equation was expanded using the singular eigenfunction expansion method of Case. A superposition of the elementary solutions of the homogeneous transformed equation were used to construct a solution of the inhomogeneous equation with the expansion coefficients determined by the boundary conditions. The time dependence was recovered by the inverse Laplace transform where the path of integration was deformed to the left as far as possible. To demonstrate the method of solution, three problems are outlined: an albedo problem, a two adjacent half-space problem, and an initial value problem. An exact eigenvalue condition is derived in the solution of the initial value problem and the eigenvalues are calculated. (Diss. Abstr.)

28225 THEORY OF SCATTERING OF SLOW NEUTRONS IN PARAMAGNETS IN A STRONG MAGNETIC FIELD. Akhiezer, I. A.; Barts, B. I. (Kharkov State Univ.). Sov. Phys.-Solid State (Engl. Transl.), 10: 2483(Apr. 1969).

Translated from Fiz. Tver. Tela, 10: 3142-4(Oct. 1968).

Equations are derived which show that the scattering cross section for neutrons with excitation or absorption of sound depends significantly on the intensity of the field H_0 and differs from that of the analogous process in nonmagnetic bodies. (D.L.C.)

28226 ENERGY DEPENDENT DIFFUSION AND TRANSPORT NEUTRON WAVE PROPAGATION IN AN INFINITE MEDIUM. Baldonado, Orlino C.; Erdmann, Robert C. (Univ. of California, Los Angeles). Nukleonik, 12: 57-62(Jan. 1969).

The energy-dependent neutron diffusion and transport equations are solved with isotropic scattering and a one-term degenerate kernel in an infinite medium containing an oscillating plane source. The diffusion equation is solved exactly by separation of variables, as is the transport equation by applying a technique due to Cercignani. The energy variable in diffusion theory is seen to give a one-dimensional continuum of solutions, in addition to two discrete solutions. Both the angular and energy variables give rise to continuum solutions in the transport case resulting in an area continuum of solutions. In addition to the transport continuum, there are also two discrete solutions below a certain limiting frequency. Upon integration of the angular variable, it is seen that the discrete transport solution reduces to the discrete diffusion solution for those values of E and ω such that $\omega/v\Sigma_t(E) \ll 1$. Numerical calculations are given for constant scattering and 1/v absorption to show the propagation constants of the waves. The discrete amplitude and phase shift from the two theories are compared by looking at deviations from the Maxwellian distribution, and the results agree very well for both theories. For any given energy, the waves are seen to propagate like one-speed ones. There is, however, a change in the energy dependent amplitude and phase shift for each change in the energy and frequency. Graphs to show these changes are given. (auth)

28227 METHODS FOR ALBEDO MATRIX CALCULATION. Vertes, P. (Central Research Inst. for Physics, Budapest). Nukleonik, 12: 67-75(Jan. 1969).

The Peierls integral equation is applied to the determination of albedo matrix elements in one-dimensional geometries. In the case of thin layers (thickness is much less than the scattering mean free path) explicit expressions for albedo matrices are given. The operators of extremely thin layers are used in Ambarcumyan's non-linear equations of invariant imbedding theory. These equations are reproduced in this paper, and are solved in some important special cases. The possible methods of albedo matrix calculation are compared and the criteria of the applicability of each are given. (auth)

28228 MEASURING THE TEMPERATURE DEPENDENCE OF NEUTRON DIFFUSION IN ZIRCONIUM HYDRIDE. Knoche, Mireille (Kernforschungszentrums, Karlsruhe, Ger.). Nukleonik, 12: 84-7(Jan. 1969). (In German).

The local variation of the neutron spectrum during a sudden change of temperature in a zirconium hydride medium was studied. The measurement was carried out using Lu and Cu probes in slab geometry in which part of the medium was held at room temperature, the rest at 250, 350, or 400°C. The measurement yielded the temperature dependence of the diffusion length and also that of the rethermalization length. The rethermalization cross sections were found to be 4.5 ± 0.8 or 6.8 ± 1.06 for the diffusion of warm neutrons in a cold medium or cold neutrons in a warm medium. The measurements agreed well with numerical calculations which were performed using the synthetic von Reichardt scattering kernel. (tr-auth)

28229 NEUTRON SCATTERING BY POLYETHYLENE. Sprevak, D.; Koppel, J. U. (Gulf General Atomic Inc., San Diego, Calif.). Nukleonik, 12: 87-92(Jan. 1969).

The dispersion relations for an infinite chain of CH_2 radicals and the polarization vector for each normal frequency were calculated. The weighted frequency spectrum was calculated using these results. The scattering law for polyethylene was determined and used to calculate the neutron cross sections. The results were compared with experimental data. (J.W.R.)

28230 SINGLE-PHONON SCATTERING OF NEUTRONS ON LIQUID LEAD. Khrushchev, B. I.; Sharipova, L. S. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. No. 4, 68-71(1968). (In Russian).

Debye formulas for differential and integral cross sections were obtained on the basis of a quasicrystalline liquid model. The inelastic and elastic neutron scattering was considered as scattering in two regions; the liquid and the crystalline. Moreover, diffraction scattering in the liquid region of the nearest proximity area determined the shape of the angular distribution. An analysis of curves constructed for elastic and inelastic scatterings on liquid zinc at 550 and 350°C revealed a clear coincidence between the calculated diffraction curve and experiment. The agreement of the scattering cross sections with experimental data confirms the concept of the proximity of the liquid and crystalline states of liquid lead at $T \leq 10^{-12}$ sec. (R.V.J.)

Nuclear Properties and Reactions, $A \leq 5$

Refer also to abstracts 26540, 28267, and 28304.

28231 (BNL-tr-263) ON THE SPIN DEPENDENCE OF THE INTERACTION OF SLOW NEUTRONS WITH DEUTERIUM, NITROGEN, AND LANTHANUM NUCLEI. Ivanenko, A. I.; Lushchikov, V. I.; Taran, Yu. V.; Shapiro, F. L. (Joint Inst. for Nuclear Research, Dubna (USSR). [Lab. of Neutron Physics]). Translated by Stephen J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from report JINR-P3-4185. 11p. Dep. CFSTI.

The transmission effect and polarization cross sections were measured for the interaction of slow polarized neutrons with deuterium, lanthanum, and nitrogen. From these data the quartet and doublet n-d scattering lengths were determined. (J.W.R.)

28232 (SAL-12) ANNUAL REPORT, SEPTEMBER 1967-NOVEMBER 1968. (Saskatchewan Univ., Saskatoon. Saskatchewan Accelerator Lab.). Dec. 1968. 91p. Dep.

Research carried out in the period September, 1967 at the Saskatchewan Accelerator Laboratory to November, 1968 is described. Modifications to the electron lineac and the design of a storage ring are discussed. Data are reported on electrodisintegration and photodisintegration experiments on light nuclei as well as other reactions involving the bremsstrahlung and electron scattering facilities. (J.W.R.)

28233 NEGATIVE PARITY STATES OF ^{4}He. Kalade, H. A. (Univ., Vilnyus, USSR). Liet. Fiz. Rinkinys, Liet. TSR Mokslu Akad., Liet. TSR Aukst. Mokyklos, 7: 743-9(1967). (In Russian).

Low negative parity states in ^{4}He were studied with a function previously proposed by the author which includes tensor forces. The existence of three levels with $T = 0$, $J^\pi = 1^-, 2^-, 0^-$ in a range of approximately 3 MeV was established. The levels can be related to previously established states with excitation energies of 21 to 24 MeV. (J.W.R.)

28234 THE (n,2n) CROSS SECTION OF ^{2}H IN THE ENERGY REGION 4.0 TO 6.5 MeV. Holmberg, M. (Research Inst. of National Defence, Stockholm). Nucl. Phys., A129: 327-30 (1969).

The (n,2n) cross section of ^{2}H was measured in the energy region 4.0 to 6.5 MeV. The observed cross sections agree with earlier calculations by Frank and Gammel. (auth)

28235 ANALYZING POWER AND PHASE-SHIFT ANALYSIS OF PROTON-HELIUM ELASTIC SCATTERING AT 70 AND 80 MeV. Perez-Mendez, V.; Sperinde, J. M.; Stetz, A. W. (Univ. of California, Berkeley). Phys. Lett., 28B: 648-50(Mar. 17, 1969).

A helium-filled streamer chamber was used to measure the analyzing power of proton-helium elastic scattering at 70 and 80 MeV incident proton energy. Phase-shift analyses of data at 63, 70, 80 and 94 MeV yielded solutions which vary smoothly with energy and are consistent with results at lower energies. (auth)

28236 MEASUREMENTS ON THE DIFFERENTIAL CROSS SECTION OF n-p SCATTERING BELOW 3 MeV. Czibok, T.; Hrehuss, Gy.; Kovacs, I.; Nagy, L.; Vinnay, I. (Central Research Inst. for Physics, Budapest). Phys. Lett., 29B: 105-7(Apr. 14, 1969).

The cross-section ratio $\sigma(0^0)/\sigma(30^0)$ measured at neutron energies $E_n = 2.5$, 2.7 and 2.8 MeV is significantly larger than unity, which is incompatible with the generally assumed isotropy at these energies. (auth)

28237 ADLER'S SELF-CONSISTENCY CONDITION FOR NUCLEI. Faeldt, G.; Locher, M. P. (CERN, Geneva). Nucl. Phys., B10: 283-8(1969).

It is shown that Adler's self-consistency condition for light nuclei (^{4}He, ^{12}C, ^{9}Be, etc.) implies the smallness of the contribution from the unphysical region to charge symmetric π-nucleus forward dispersion relations. (auth)

28238 ABSORPTION OF π-MESONS BY ^{3}He. Figureau, A.; Ericson, M. (Univ., Lyon). Nucl. Phys., B10: 349-67(1969).

The capture rates for the absorption of negative and positive pions in ^{3}He were calculated using a phenomenological two-nucleon Hamiltonian. The effective coupling constants are redetermined from recent experiments. The sensitivity of the capture rates to the nuclear wave function is discussed. (auth)

28239 COMPARISON OF THE REACTIONS D(d,p)T AND D(d,n)^{3}He AT 83 MeV. Roy, M.; Bachelier, D.; Bernas, M.; Boyard, J. L.; Brissaud, I.; Detraz, C.; Radvanyi, P.; Sowinski, M. (Institut de Physique Nucleaire, Orsay, France). Phys. Lett., Lett., 29B: 95-6(Apr. 14, 1969). (In French).

The differential cross sections of the four-nucleon reactions D(d,p)T and D(d,n)^{3}He were measured at 83 MeV for the whole angular range. They coincide within the experimental accuracy, in agreement with the charge symmetry of nuclear forces. (auth)

28240 INVESTIGATION OF THE REACTION ^{4}He(γ,n)^{3}He AT THE γ-QUANTA MAXIMAL ENERGY OF 120 MeV. Arkatov, Yu. M.; Vatset, P. I.; Voloshchuk, V. I.; Klyucharev, A. P.; Marchenko, V. L.; Khodyachikh, A. F. (Physical-Technical Inst., Kharkov). Yadern. Fiz., 9: 473-7(Mar. 1969). (In Russian).

The reaction ^{4}He(γ,n)^{3}He was investigated at the γ-quanta maximal energy of 120 MeV by means of a diffusion chamber. The experiment was performed at the 300-MeV electron linear accelerator of the Ukranian PTI. The total effective cross section as a function of the γ energy, angular distributions, and other data were obtained. The results are compared with those from works by other authors. Some new regularities are observed. In particular, the differential cross sections taken for energy intervals narrower than those known from the literature, indicate an asymmetry with reference to the angle of 90° of the neutron angular distribution in the c.m. frame. The sign of the asymmetry is altered. (auth)

28241 UNRESTRICTED VARIATIONAL CALCULATION ON LIGHT NUCLEI. Urban, L. (Hungarian Academy of Sciences, Budapest). Phys. Lett., 29B: 91-2(Apr. 14, 1969).

A general variational procedure based on the method of steepest descent in Hilbert space is given for the calculation of some nuclear levels. (auth)

Nuclear Properties and Reactions, $6 \leq A \leq 19$

Refer also to abstracts 26540, 27784, 28231, 28232, 28237, 28304, and 28331.

28242 (ANU-P-434) DEPARTMENT OF NUCLEAR PHYSICS ANNUAL REPORT, 1968. Titterton, E. W. (Australian National Univ., Canberra. Research School of Physical Sciences). Jan. 1969. 46p. Dep.

BERYLLIUM-8—energy levels from lithium-7 (He-3,d) reactions, widths for, (E)
BERYLLIUM-9—deuteron elastic scattering at 63 MeV using polarized beams, tensor polarization in, (E)
—deuteron reactions (d,p) with, angular distributions for, (E)
BORON-10—deuteron reactions (d,p) with, angular distributions for, (E)
BORON-11—deuteron reactions (d,p) with, angular distributions for, (E)
—alpha reaction (α,γ) at 1.4 to 2.3 MeV, excitation functions for, (E)
—helium-3 reactions (He-3,γ) at 0.8 to 2.5 MeV, excitation functions for, (E)
CARBON-12—deuteron reactions (d,p) with, angular distributions for, (E)
—helium-3 reactions (He-3,p) at 3 to 8 MeV, excitation functions for, (E)
CERIUM-140—energy level at 2.516 MeV, spin assignment for, (E)
CHROMIUM-54—deuteron reactions (d,p) at 8 MeV, angular distributions for, (E)
—deuteron elastic scattering at 8 MeV, angular distributions for, (E)
CHROMIUM-55—energy levels from chromium-54 (d,p) reactions, spin assignments for, (E)
COBALT-57—energy levels from iron-54 (α,pγ) reactions, spin-parity assignments for, (E)
COBALT-59—energy levels from iron-56 (α,pγ) reactions, spin-parity assignments for, (E)
COBALT-61—energy-level transitions from iron-58 (α,pγ) reactions, (E)
FLUORINE-19—proton reactions (p,α) at 1.9 to 4.2 MeV, angular distributions for, (E)
IRON-54—alpha reactions (α,pγ) with p-γ angular correlations for, (E)
IRON-56—alpha reactions (α,pγ) with p-γ angular correlations for, (E)
IRON-58—alpha reactions (α,pγ) with p-γ angular correlations for, (E)
LITHIUM-6—helium-3 reactions (He-3,p) 2α at 1.25 MeV, p-α coincidence spectra for, (E)
—deuteron reactions (d,p) with, angular distributions for, (E)
LITHIUM-7—helium-3 reactions (He-3,d) at 15 MeV, deuteron spectra for, (E)
—deuteron reactions (d,p) with, angular distributions for, (E)
NEON-19—energy level at 2.78 MeV from neon-20 (He-3,α) reactions, spin assignment for, (E)
NEON-20—helium-3 reactions (He-3,α) up to 15 MeV, angular distributions for, (E)
NICKEL-62—proton elastic scattering at 8.0 to 8.05 MeV, angular distributions for, (E)
—proton reactions (p,nγ) with angular distributions for, (E)
NICKEL-64—proton reactions (p,nγ) with, angular distributions for, (E)
NITROGEN-14—proton reactions (p,γ) at 1.7 to 3.1 MeV, cross section for, (E)
OXYGEN-16—deuteron elastic scattering at 6.25 MeV, tensor polarization from, (E)
—deuteron reactions (d,p) and (d,α) at 4.4 to 8.4 MeV, differential cross sections for, (E)
OXYGEN-18—proton reactions (p,n) and (p,α) at 3 to 7 MeV, excitation functions for (E)
—proton inelastic scattering at 3 to 7 MeV, excitation function for, (E)
PHOSPHORUS-31—proton elastic scattering at 8 to 10 MeV, excitation functions for, (E)
POTASSIUM-39—proton reactions (p,γ) with, γ spectra for, (E)
POTASSIUM-41—proton reactions (p,n) at 1.2 to 2.3 MeV, threshold energy and neutron yield for, (E)
SILICON-29—proton reactions (p,γ) at 1.4 to 2.2 MeV, cross section for, (E)
SODIUM-23—proton elastic scattering at 8 to 12 MeV, excitation functions for (E)
SULFUR-32—energy levels from proton resonances in phosphorus-31, widths for, (E) (J.W.R.)

28243 (BARC-364) VAN DE GRAAFF LABORATORY PROGRESS REPORT. David, T. P. (comp.) (Bhabha Atomic Research Centre, Bombay (India)). 1968. 74p. Dep.

ALUMINUM-27—proton reactions (p,α) at 4 to 5.5 MeV, excitation functions for (E)
CARBON-12—helium-3 reactions (He-3,p) at 5.5 MeV, angular distributions for (E)
—helium-3 elastic scattering at 5.5 MeV angular distribution for (E)
CARBON-13—alpha reactions (α,n) at 4.1 to 4.5 MeV, angular distributions for (E)
FLUORINE-19—alpha reactions (α,p) at 3 and 4 MeV, proton spectra for (E)
—alpha elastic scattering at 3 and 4 MeV, alpha spectra for (E)
—proton reactions (p,α) at 2.0 to 3.6 MeV, α spectra and excitation functions for (E)
—deuteron reactions (d,α) at 2 to 5.2 MeV, excitation functions for (E)
GAMMA RADIATION—detection using lithium-drifted germanium detector, Monte Carlo calculation of energy losses in
GAMMA SPECTROMETERS—design of scintillation, for measuring charged particle-γ angular correlations
NEON-20—energy levels from proton resonances in fluorine-19, widths for compound nucleus (E)
NEON-21—energy levels from intermediate structure in fluorine-19 (d,α) reactions, widths for (E)
RADIATION DETECTORS, SEMICONDUCTOR (GERMANIUM)—gamma energy losses in lithium-drifted, Monte Carlo calculation of
SILICON-28—deuteron reactions (d,pγ) at 2.5 to 3.1 MeV, p-γ angular correlations for (E)
—energy level at 14.378 MeV from alpha resonances in magnesium-24, spin-parity assignment and width for (E)
SILICON-29—energy level at 3.067 MeV from silicon-28 (d,pγ) reactions, spin-parity assignment for (E)
—alpha reactions (α,n) at 3.0 to 5.4 MeV, excitation functions for (E)
SPECTROMETERS—design of semiconductor for measuring charged particle-γ angular correlations
—design of silicon $\Delta E-E$, for mass identification of charged particles
VANADIUM-51—proton reactions (p,n) at 2.2 to 2.8 MeV, excitation functions for (E)
VAN DE GRAAFF ACCELERATORS—research and development at Trombay 5.5-MeV, Jan. 1, 1967 to June 30, 1968 (J.W.R.)

28244 (KFK-871) ELASTIC SCATTERING OF 104 MeV ALPHA PARTICLES. Hauser, G.; Loehken, R.; Rebel, H.; Schatz, G.; Schweimer, G. W.; Specht, J. (Kernforschungszentrum, Karlsruhe (West Germany)). Dec. 1968. 67p. (In German). Dep.

The differential elastic scattering cross sections were measured for the scattering of 104-MeV alpha particles on ^{6}Li, ^{9}Be, ^{12}C, ^{14}N, ^{16}O, ^{20}Ne, ^{40}Ar, ^{64}Ni, ^{90}Zr, ^{124}Sn, ^{208}Pb, and ^{209}Bi. All angular distributions show a pronounced diffraction pattern. For the lightest nuclei measured (^{6}Li to ^{16}O) the cross section exceeds the Rutherford cross section by a factor up to 15 at angles around 45°. The cross section data were analyzed in terms of parametrized phase-shift functions using 9 free parameters and in terms of the spinless optical model using up to 7 free parameters. Good fits were obtained. A strong absorption was found for the heavy nuclei, $A \geq 124$. For these nuclei, only the outermost region of the nuclear surface contributes to the scattering. A potential radius cannot be extracted regardless of the pronounced diffraction pattern. The absorption is not so strong for the medium weight nuclei, $20 \leq A \leq 90$. Information about the nuclear surface can be extracted from the differential cross section. The well-known phase ambiguity in the optical model was found for these nuclei. For the light nuclei ($A \leq 16$) the inner region of the interaction potential contributes to the scattering. A repulsive core for small interaction distances was able to explain the observed cross sections which indicates the nonlocal character of the true interaction. The phase-shift analysis leads to good fits, but the phase shifts obtained differ significantly from those of the optical model analysis. This indicates that the phase-shift analysis is ambiguous too. (auth)

28245 (LAL–1208) INELASTIC NUCLEAR ELECTRON SCATTERING IN THE INDEPENDENT PARTICLE MODEL. De Forest, Taber Jr. (Massachusetts Inst. of Tech., Cambridge. Paris Univ., Orsay (France). Laboratoire de l'Accelerateur Lineaire). Jan. 1969. 31p. Dep.

The quasi-elastic model of nuclear electroexcitation was generalized to include the effects of binding and the distortion of the wave function of the emitted nucleon by an energy-dependent nuclear potential. The model predicts cross sections which are in good agreement with the inelastic spectra observed in ^{12}C experiments. For ^{16}O, however, the experimental cross sections are larger than predicted, especially for small energy transfers. This may be due to correlations associated with multi-particle-hole excitations which are not included in the model. The inclusion of the Perey effect, which is necessary to guarantee the usual electron scattering sum rules, was found to be very important, reducing the cross sections by 30 to 40%. (auth)

28246 (USC–136-146) NUCLEAR PHYSICS RESEARCH LABORATORY. Annual Progress Report. (University of Southern California, Los Angeles. Dept. of Physics). Oct. 1968. Contract AT(04-3)-136. 59p. Dep. CFSTI.

The activities of the Nuclear Physics Laboratory of the University of Southern California for the period Oct. 1, 1967 to Sept. 30, 1968 are described. Data are reported on various proton induced nuclear reactions, instrumentation and detector studies, and on charged particle energy losses in matter. (J.W.R.)

28247 LIFETIMES IN ^{17}O, ^{39}K, AND ^{45}Ca BY A PARTICLE-γ COINCIDENCE TECHNIQUE. Gorodetzky, S.; Merdinger, J. C.; Schulz, N.; Knipper, A. (Institut de Recherches Nucleaires, Strasbourg). Nucl. Phys., A129: 129-37(1969). (In French).

Proton-gamma delayed-coincidence measurements in the reactions ^{16}O(d,pγ)^{17}O, ^{39}K(p,p$'\gamma$)^{39}K and ^{44}Ca(d,pγ)^{45}Ca yield half-lives of $T_{1/2}$ = 181 ± 5, ≤78, and 400 ± 40 ps for the levels ^{17}O(871 keV), ^{39}K(2817 keV) and ^{45}Ca(174 keV), respectively. The first mentioned half-life has been used as a check on the experimental technique; the two other values are discussed in the light of current nuclear models. (auth)

28248 STUDY OF ^{15}O BY MEANS OF ^{3}He + ^{12}C REACTIONS. Weller, H. R.; Van Rinsvelt, H. A. (Univ. of Florida, Gainesville). Nucl. Phys., A129: 64-80(1969).

Angular distributions and excitation curves were measured for the ^{12}C(^{3}He,^{3}He)^{12}C, ^{12}C(^{3}He,α_0)^{11}C and ^{12}C(^{3}He,α_1)^{11}C reactions between E(^{3}He) = 5.0 and 8.0 MeV in 100-keV steps. Strong resonance structures have been observed. An optical-model-plus-resonance (OMPR) analysis of the elastic scattering data indicates that a potential similar to that used at higher energies can describe much of our data if two resonances are introduced near 7 MeV and two between 4.5 and 6.0 MeV. A phase shift analysis of these data was also performed with results in accord with the OMPR analysis. A Legendre polynomial expansion was made of the α_0 data. (auth)

28249 POLARIZATION AND PHASE SHIFTS IN ^{6}Li(p,p)^{6}Li FROM 0.5 TO 5.6 MeV. Petitjean, Claude (Univ. of Basel); Brown, Louis; Seyler, Richard G. Nucl. Phys., A129: 209-19 (1969).

Angular distributions of polarization in ^{6}Li(p,p)^{6}Li were measured to an accuracy of about 0.01 at 11 energies from 1.2 to 3.2 MeV with a target of 20-keV thickness at 2 MeV. These data and cross section measurements of others are reproduced well by a set of phase shifts, which vary reasonably with energy and which are complex because a reaction channel is open. The ^{2}S-, ^{4}S- and ^{4}P-phases suffice for the analysis. Neither ^{2}P-phases nor mixing parameters are found to be important. The $^{4}P_{5/2}$ phase resonates at 1.8 MeV as expected. The broad resonance at 5 MeV can be reproduced equally well with either the $^{4}P_{1/2}$ or the $^{4}P_{3/2}$ phase resonating, the former agreeing with a previous spin assignment. Measurements of cross section, proton polarization and ^{6}Li vector polarization cannot distinguish between the two sets, but measurements of ^{6}Li tensor polarization could. The uniqueness of the phases is discussed and a polarization contour map is presented. (auth)

28250 RADIATIVE PION CAPTURE IN COMPLEX NUCLEI. Kawaguchi, Masaaki; Ohtsubo, Hisao; Sumi, Yoshio (Osaka Univ.). Progr. Theor. Phys. (Kyoto), Suppl. Extra No., 28-43 (1968).

Radiative pion capture in ^{16}O was investigated. The effective interaction Hamiltonian and the general formalism of the capture rates are given in parallel with muon capture and electron scattering. The partial capture rates in ^{16}O were calculated by the use of the shell model and were found to be consistent with experiment. The observed peak of the gamma-ray spectra was interpreted as the giant resonance similar to that of photoabsorption. The absolute values of the transition rates are predicted in comparison with the muon capture reaction. (auth)

28251 COMMENT ON THE COLLECTIVE EXCITATION IN ^{12}C(p,p$'$)^{12}C* REACTION. Koga, Tadao; Takemiya, Toshinori (Kumamoto Univ., Japan). Progr. Theor. Phys. (Kyoto), Suppl. Extra No., 137-45(1968).

Differential cross sections and polarizations were calculated for the inelastic scattering of high-energy nucleons from the collective excited states of ^{12}C, E_{exc} = 4.43 MeV 2^+ T = 0, 9.63 MeV 3^- T = 0, and 22.3 MeV 1^- T = 1, using one particle-hole and one hole-particle amplitudes which were obtained by Goswami and Pal, and Gillet and Vinh Mau. In the framework of plane wave impulse approximation (P.W.I.A.), polarizations were well reproduced, but cross sections were not. (auth)

28252 A STUDY OF THE ^{12}C(^{3}He,$\alpha_{0,3}$)^{11}C AND ^{16}O(^{3}He,$\alpha_{0,3}$)^{15}O REACTIONS AT 13.9 MeV. Ober, David Ray. Lafayette, Ind., Purdue Univ., 1968. 117p.

Thesis.

The 13.9-MeV differential cross sections for the (^{3}He,α) reactions which lead to the ground, 2.00-, 4.32-, and 4.81-MeV states of ^{11}C, and to the ground and 6.16-MeV states of ^{15}O were measured at 2.5° intervals over a laboratory angular range from about 15 to 100°. Concurrent measurements of the angular distributions for the elastic scattering of ^{3}He particles from ^{12}C and ^{16}O were made along with the corresponding (^{3}He,α) study. The ^{3}He- and α spectra were measured using a four-counter (silicon surface-barrier detectors) spectrometer system. In the ^{12}C studies a single self-supporting carbon-foil target (220 ± 11 μg/cm^2) was used. The two targets used in the ^{16}O investigation were fabricated from 0.15-mil Mylar film, and they had total thicknesses of 520 ± 26 and 527 ± 26 μg/cm^2 of which 173 ± 9 and 176 ± 9 μg/cm^2, respectively, were oxygen. The gross features of the six angular distributions suggest that a direct-reaction mechanism is operative and may be dominant. The partial integrated cross sections for the common center-of-mass angular ranges (32 to 112° for the ^{12}C(^{3}He,α)^{11}C reactions and 18 to 106° for the ^{16}O(^{3}He,α)^{15}O reactions) are 30.5, 9.2, 9.7, and 11.9 mb for the production of the ground and first three excited states of ^{11}C; and 15.6 and 25.7 mb for the production of the ground and third excited state of ^{15}O. Each angular distribution was analyzed in terms of Tobocman's zero-range distorted-wave Born-approximation knockout and pickup models. It was found that somewhat more than the gross features of the experimental angular distributions can be reproduced by one or the other, not both, of these models. For the ^{12}C(^{3}He,α_n)^{11}C reactions, the angular distributions associated with the α_0 and α_2 groups could only be fitted with the pickup model and those associated with the α_1 and α_3 groups could only be fitted with the knockout model. For the ^{16}O(^{3}He,α_n)^{15}O reactions, the angular distributions which correspond to the α_0 and α_3 groups could only be fitted with the pickup model. A speculative, qualitative rationalization of these results, which is based on the single-particle and/or α-cluster character of the initial and final nuclear states, is presented. The 13.9-MeV elastic ^{3}He-particle cross sections for ^{12}C and ^{16}O were analyzed in terms of four-parameter nuclear optical-model potentials. Although fairly good qualitative agreement was achieved between the theoretical and experimental cross sections at forward angles, the agreement deteriorated progressively with increasing angle. (Disser. Abstr.)

28253 DIRECT-SEQUENTIAL ORDER-OF-EMISSION INTERFERENCE EFFECT. Stotland, Victor G. Urbana, Ill., Univ. of Illinois, 1968. 157p.

Thesis.

The reaction ^{9}Be(^{3}He,α)^{8}Be* → α + α was studied at incident beam energies of 27.4 and 27.8 MeV. Two solid-state detectors were mounted in the reaction plane and set at such angles that the peak corresponding to the ^{9}Be(^{3}He,α)^{8}Be($E_{excit.}$ = 11.4 MeV) and the peak due to ^{8}Be($E_{excit.}$ = 11.4 MeV) → 2α, as seen in a given detector, were superimposed over a wide angular range. The results show that for E_p = 27.8 MeV, θ_1 = 77, θ_2 = 60, and for E_p = 27.4 MeV, θ_1 = 80, θ_2 = 59, there is order-of-emission destructive interference, where a peak due to the superimposition of the two closely spaced peaks is expected. Assuming no interference is present the width of the 11.4 MeV level of ^{8}Be*, as deduced from the separation of the two peaks, is less than 2.5 MeV, a value which is considerably smaller than the known width of 4.0 MeV. On the other hand, using coherent addition of two Breit–Wigner line shapes characterized by widths of 4.0 MeV, one can predict a dip between the two peaks that is in qualitative agreement with the experimental data. (Disser. Abstr.)

28254 SHELL-MODEL CALCULATION OF ODD-PARITY STATES IN THE A = 6 AND 14 SYSTEMS. Cooper, Benjamin Stubbs. Charlottesville, Va., Univ. of Virginia, 1968. 145p. Thesis.

Odd parity excitations for the A = 6 and = 14 nuclei are calculated within the framework of the particle-hole shell model, with a consistent treatment of core-excited configurations as well as excitations which affect only extra-core particles. Spurious states are removed, and a finite-range (gaussian) residual interaction with Wigner, Majorana, Heisenberg, and Bartlett exchange components is diagonalized in the non-spurious subspace for all possible J and T values. Using formulas which connect the spurious states with the operator for dipole photoexcitation, the resulting eigensolutions are used to obtain absolute dipole strength distributions for these nuclei. A detailed comparison of the resulting distributions and the calculated level spectra with experimental data is made. In addition, normal parity results for the A = 6 and 14 systems and the A = 7 and 13 systems are presented and considered in the light of experiment. (Disser. Abstr.)

28255 THE (n,2n) CROSS SECTION OF ^{9}Be IN THE ENERGY REGION 2.0 TO 6.4 MeV. Holmberg, M.; Hansen, J. (Research Inst. of National Defence, Stockholm). Nucl. Phys., A129: 305-26(1969).

The (n,2n) cross section of ^{9}Be was measured in the energy region 2.0 to 6.4 MeV with an accuracy of about 8% above 3.2 MeV. The two neutrons in the (n,2n) reaction were detected by a large liquid scintillator by measuring the correlation time between the pulses due to the two neutrons. The (n,2n) cross section increases rapidly above the threshold at 2.70 MeV for the inelastic neutron scattering to the 2.43-MeV level of ^{9}Be, which subsequently decays by neutron emission. There also exists a small (n,2n) cross section in the energy range 2.0 to 2.7 MeV. (auth)

28256 SEQUENTIAL DECAY IN THE REACTIONS ^{14}N(α,αp)^{13}C AND ^{14}N(α,αd)^{12}C AT E_α = 22.9 MeV. Baehr, K. (Max-Planck-Institut fuer Kernphysik, Heidelberg); Becker, T.; Jahr, R.; Kuhlmann, W. R. Nucl. Phys., A129: 388-404(1969).

Correlations in the reactions ^{14}N(α,αp) and ^{14}N(α,αd) were measured in a coplanar geometry with three-dimensional pulse-height analysis. The α-particles were detected with a solid-state detector and the coincident protons and deuterons with a dE/dx-E solid-state detector telescope. The telescope was fixed at 25°, whereas the position of the α-particle detector was varied. Transitions to the ground states of ^{13}C and ^{12}C and rather weak transitions to excited states of ^{13}C were observed. The energy spectra of the transitions to the ground states of ^{13}C and ^{12}C show a pronounced peak structure as is expected from a sequential reaction mechanism. The kinematics of these peaks indicate a selective population of levels in the intermediate nuclei ^{14}N, ^{16}O, ^{17}O and of the 2.184-MeV level in ^{6}Li. The selection of the levels can almost completely be understood on the basis of parity and isospin conservation, the influence of competing channels, some spectroscopic properties of the levels involved, and angular momentum arguments. (auth)

28257 A STUDY OF PROTON SCATTERING ON ^{12}C AND ^{13}C AT 7 MeV. Guratzsch, H.; Hofmann, G.; Mueller, H.; Stiller, G. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Nucl. Phys., A129: 405-16(1969).

Differential cross sections and polarizations of proton scattering on ^{12}C and ^{13}C were measured at E_p = 7 MeV. Total ^{12}C + p and ^{13}C + p reaction cross sections were estimated. Optical model analyses indicate that the elastic scattering data cannot be satisfactorily described by averaged parameters. The deduced optical parameters were used in some DWBA calculations. (auth)

28258 DISCOVERY OF $11/2^+$ LEVEL IN ^{19}F. Aitken, J. H.; Allen, K. W.; Azuma, R. E.; Litherland, A. E.; Rogers, D. W. O. (Univ. of Toronto). Phys. Lett., 28B: 653-5(Mar. 17, 1969).

A resonance was discovered in the ^{15}N(α,γ)^{19}F reaction which strongly populates the recently-discovered [1] $13/2^+$ level at 4.648 MeV in ^{19}F. Measurements show that it corresponds to a level with spin $11/2$ in ^{19}F at E_x = 6.500 MeV. (auth)

28259 A COMMENT ON THE REACTION ^{10}B(t,p)^{12}B. Soerensen, B. (Univ. of California, Berkeley). Phys. Lett., 28B: 633-7(Mar. 17, 1969).

The ^{10}B(t,p) ground state angular distribution has been quoted as one of the clearest indications of a two-step reaction mechanism. As, however, no DWBA calculations were performed, one might doubt whether the unusual angular distribution was not due to coincidental peculiarities lost in the plane wave description. Our DWBA calculation indicates that the basis for ruling out a one-step mechanism is weakened when distorted waves are introduced, but that there is still room left for components of various two-step mechanisms. (auth)

28260 ON THE MUON CAPTURE IN ^{6}Li. Krueger, J.; Van Leuven, P. (Rijksuniversitair Centrum, Antwerp. Studiecentrum voor Kernenergie, Mol, Belg.). Phys. Lett., 28B: 623-4 (Mar. 17, 1969).

The muon capture rate in ^{6}Li leading to the ground state of ^{6}He was calculated from the magnetic form factor of ^{6}Li, using projected Hartree-Fock wave functions. (auth)

28261 ALPHA PRODUCTION BY 28.5-BeV PROTON INCIDENT ON BERYLLIUM OXIDE. Wang, C. L. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett., 22: 1011-13 (May 12, 1969).

A sizable number of α particles were detected at 18.8° in p-BeO collisions at 28.5 BeV. The alpha-to-deuteron ratio is found to be of the order of 1% for secondary momenta below 1000 MeV/c per nucleon. Possibilities of obtaining secondary alpha beams at high-energy accelerators for various experiments, in particular those relevant to the study of the origin and propagation of cosmic rays, are discussed. (auth)

28262 INVESTIGATION OF THE ^{9}Be + T REACTION. Kim Syn Nam; Osetinskii, G. M. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 9: 487-93(Mar. 1969). (In Russian).

Differential cross sections of the reactions ^{9}Be(t,α_0)^{8}Li, ^{9}Be(t,α_1)^{8}Li, ^{9}Be(t,d_0)^{10}B were measured on thin solid target at the angles of 90 and 70° for energies from 520 up to 1700 keV. Angular distributions of both the groups of α particles are measured for several triton energy values. It was established that in the range of excited energy of the compound nucleus ^{12}Be from 13.3 up to 14.2 MeV there are no sufficiently narrow energy levels. The shape of α-particle angular distributions varying smoothly with the energy indicates a substantial contribution from the direct interaction processes. Total cross sections for the mentioned groups of α particles were obtained. (auth)

28263 A = 6 NUCLEI AS THREE-BODY SYSTEMS. Alessandrini, V. A. (International Centre for Theoretical Physics, Trieste, Italy); Avalos, D.; Epele, L.; Fanchiotti, H.; Garcia Canal, C. A.; Gregorio, M. A. Phys. Lett., 29B: 83-5(Apr. 14, 1969).

Using three-body models, the binding energies of the ground states of ^{6}He and ^{6}Li are computed. (auth)

28264 CHARGE-EXCHANGE SCATTERING OF PIONS BY ^{14}N. Sakamoto, Y. (Institut de Physique Nucleaire, Orsay, France). Phys. Lett., 29B: 88-90(Apr. 14, 1969).

The cross section for the reaction ^{14}N(π^+,π^0)^{14}O is calculated for the energy region of the pion-nucleon (3,3) resonance. The total cross section σ calculated is 0.06 mb at the pion laboratory kinetic energy of 180 MeV, which agrees with the observed value $\sigma \lesssim 0.08$ mb. (auth)

28265 PIONIC 2p LEVEL WIDTHS IN LIGHT NUCLEI. Koch, H.; Krell, M.; Malsburg, Ch. V. D.; Poelz, G.; Schmitt, H.; Tauscher, L.; Backenstoss, G.; Charalambus, S.; Daniel, H. (CERN, Geneva. Max-Planck-Institut fuer Kernphysik, Heidelberg. Univ., Karlsruhe, Ger. Technische Hochschule, Munich). Phys. Lett., 29B: 140-2(Apr. 14, 1969).

The yields of muonic and pionic 2p-1s X-ray transitions are given for Be, ^{10}B, ^{nat}B and C. Pionic 2p populations are calculated, and the natural widths of the pionic 2p levels from Be to Na are deduced by comparison with X-ray transition rates calculated with realistic pion wave functions. (auth)

28266 EXCITATION CURVES OF THE REACTIONS ^{18}O(p,$p_1\gamma$)^{18}O AND ^{18}O(p,$\alpha_{1,2,3}\gamma$)^{15}N AT 3.2 TO 5.4 MeV. Bergdolt, G.; Guillaume, G. (Centre de Recherches Nucleaires, Strasbourg). J. Phys. (Paris), 30: 145-7(Feb.-Mar. 1969). (In French).

Excitation functions of the reactions ^{18}O(p,p_1)^{18}O* and ^{18}O(p,$\alpha_{1,2,3}$)^{15}N* were measured for incident energies from 3.2 to 5.4 MeV. At some energies the excitation functions display anticorrelation effects among proton and alpha exit channels. If this effect can be ascribed to isobaric spin conservation, it indicates higher isotopic spin levels of the compound nucleus ^{19}F. (auth)

28267 ANALYSIS OF DIFFERENTIAL CROSS SECTIONS OF REACTIONS (p,d) AND (^{3}He,α) ON SOME LIGHT NUCLEI IN TERMS OF PERIPHERAL MODEL. Dolinskii, E. I.; Turovtsev, V. V. (Moscow State Univ.). Yadern. Fiz., 9: 515-27(Mar. 1969). (In Russian).

Differential cross sections of the reactions (p,d) and (^{3}He,α) on some light nuclei are calculated in terms of peripheral model of direct nuclear reactions previously proposed. Coupling constants G_{ln} for virtual processes A + n ⇄ B are obtained from comparison of theoretical cross sections with experimental ones. It is shown that one-parameter peripheral model allows one to predict absolute values of cross sections. Results of calculations on the peripheral model are compared with those obtained by means of the Butler theory and by the distorted wave method. (auth)

28268 NUCLEON ASSOCIATIONS IN NUCLEI ^{6}Li AND ^{6}He FROM DATA ON SOME REACTIONS AT HIGH ENERGIES. Kudeyarov, Ya. A.; Eramzhyan, R. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 9: 494-500(Mar. 1969). (In Russian).

In framework of the nucleon-association model the following quantities are calculated: form factor for electron inelastic scattering on ^{6}Li with excitation of the level with quantum numbers $J^\pi = 0^+$, T = 1 ($E^* = 3.56$ MeV), μ-capture probability for ^{6}Li with excitation of the level with $J^\pi = 0^+$, T = 1 in ^{4}He that is an analog of the 3.56 MeV level in ^{6}Li, and τf for the β-decay of ^{6}He. These processes are shown to be interpretable in an unified way in the framework of the nucleon-association model. (auth)

28269 CHARGE-EXCHANGE REACTION OF PIONS ON LIGHT NUCLEI. Sakamoto, Y. (Institut de Physique Nucleaire, Orsay, France). Nucl. Phys., B10: 299-306(1969).

The cross sections for the reactions $(\pi^\pm,\pi^0)$ on light nuclei are calculated for the energy region around the (3,3) resonance. The Chew–Low amplitude for pion–nucleon scattering is used in the framework of the impulse approximation. The absolute magnitudes of the cross sections are classified according to the section rule of β transitions between nuclear states involved in the reactions. The calculated results are in agreement with available data. (auth)

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Refer also to abstracts 26540, 27784, 28232, 28242–28244, 28246, 28247, and 28304.

28270 (ANL-7550, pp 93-6) NUCLEAR CONSTANTS. (Argonne National Lab., Ill.).

Monoenergetic neutron cross sections were measured for (n,γ) reactions in reactor fuels, cladding and structural materials. The isotopes found in structural materials include ^{85}Rb, ^{87}Rb, ^{50}Ti, ^{51}V, and ^{89}Y. Integral cross-section measurements were performed on specimens of type 304 L stainless steel irradiated at various positions throughout the core and blankets of EBR-II. The reactions included ^{54}Fe, ^{58}Ni, ^{60}Ni (n,p), ^{58}Ni (n,α), and ^{59}Co, ^{54}Fe, ^{60}Ni (n,γ). The production rates of ^{54}Mn and ^{55}Fe in these reactions serve as a very sensitive indicator of the reactor's spectral shape. (J.W.R.)

28271 (EURFNR-611) CARD IMAGE FORMAT OF THE KARLSRUHE EVALUATED NUCLEAR DATA FILE, KEDAK. Woll, D. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Dec. 1968. 18p. (KFK-880; EANDC-(E)-112-U; EUR-4160). Dep.

Work Performed under United States–Euratom Fast Reactor Exchange Program.

The card image format of the external KEDAK file, which contains evaluated microscopic neutron cross sections and other nuclear data of reactor materials, is described. (J.W.R.)

28272 (ITF-68-84) EXCITATION OF ISOBAR-ANALOGUE STATES IN REACTIONS OF ELASTIC SCATTERING AND RADIATION CAPTURE OF PROTONS. Kolomiets, V. M.; Tsekhmistrenko, Yu. V. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1968. 33p. (In Russian). Dep.

The theory of resonance proton reactions on heavy nuclei ($N-Z \gg 1$) with excitation of isobar-analog states is discussed. The theory takes into account different opened channels (p,p), (p,γ), (p,p'), (p,n). Simple formulas to determine nucleon and radiation widths of the analog states were obtained. The effect of isotopic spin nonconservation and a thin resonance structure arising is discussed. A numerical calculation of nucleon and radiation widths in reactions ^{88}Sr(p,p), ^{88}Sr$(p,\gamma)^{89}$Y at energies below the Coulomb barrier $E_p < \Delta_k = 1.13\ A^{1/3}$ MeV was performed. A contribution both from resonance and direct capture mechanisms was calculated in the radiation capture cross section $\sigma(p,\gamma_0)$. All the results obtained were compared with experimental data. (auth)

28273 (JINR-E6-4360) HIGH RESOLUTION SPECTROSCOPIC STUDY OF THE DECAY OF THE ^{82m}Rb and ^{82g}Rb ISOTOPES. Broda, R.; Hrynkiewicz, A. Z.; Styczen, J.; Szeglowski, Z.; Walus, W. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1969. 20p. Dep.

The level scheme of ^{82}Kr was investigated by the study of the decay of 1.3-min ^{82g}Rb and 6.3-h ^{82m}Rb using a high-resolution Ge(Li) detector and Ge(Li)-Na(Tl) coincidence system. Gamma rays of the following energies were assigned to the decay of ^{82g}Rb (relative intensities in parenthesis): 698.1(1.2); 710.5(0.2); 776.9 (100.0); 1395(3.8); 1475.1(0.7); 1705(0.4); 2169(0.35); 2411(0.17); 2481(0.3); 2945(0.7) keV. In the decay scheme of ^{82g}Rb the following levels were determined: 776.9; 1475.1; 1487.4; 2172.4; 2481.0; 2945.0; and 3188.0 keV. The spin of the 2172.4-keV level was determined to be 0 by γ-γ directional studies of the 1395.5–776.9 keV cascade. Some limitations for the spin of the other levels were made. (auth)

28274 (NEVIS-168) NEUTRON ASYMMETRY IN MUON CAPTURE. Sculli, John (Columbia Univ., Irvington-on-Hudson, N. Y. Nevis Labs.). Mar. 1969. 55p. (CU-272; R-655).

Thesis.

The neutron asymmetry in muon capture in ^{40}Ca was measured by detecting neutrons in an array of spark chambers and scintillation counters. The detection scheme permits a measurement of neutron energies in the region 10 to 30 MeV with 10% resolution. Five thousand neutrons recorded above 16 MeV give an asymmetry $+0.45 \pm 0.29$, contrary to the large negative asymmetries obtained in earlier experiments and opposite in sign to predictions based on the V-A theory and approximate descriptions of the nuclear physics. (auth)

28275 ON THE SPIN OF THE 3.32-MeV STATE IN ^{26}Si. Rolfs, C.; Trost, W. (Univ., Freiburg i. B.). Nucl. Phys., A129: 205-8(1969).

In the ^{24}Mg(^{3}He,n)^{26}Si reaction, the distribution of the neutrons feeding the 3.32-MeV state was measured. The neutron group was selected by n-γ coincidences. From DWBA calculations, L = 0 is found for the transferred diproton and $J^\pi(3.32) = 0^+$. (auth)

28276 PHOTOPROTON SPECTRA FROM ^{28}Si AT BREMSSTRAHLUNG ENERGIES 22.5, 30, 40, AND 50 MeV. .White, Thomas Arlington Jr. Charlottesville, Va., Univ. of Virginia, 1968. 69p.

Thesis.

The energy distribution of protons from ^{28}Si$(\gamma,p)^{27}$Al reaction was obtained by using a lithium-drifted silicon detector as a target, which was irradiated by bremsstrahlung having maximum energies of 22.5, 30, 40, and 50 MeV. To make this experiment possible, the pile-up arising from the high gamma background was strongly reduced by lengthening the duration of a beam burst and also by using a 75-centimeter length of graphite along the path of the beam to filter out the intense low-energy part of the bremsstrahlung. The structural features of the photoproton spectrum from the 22.5-MeV data, which agree with others' works, can be identified with the strong levels below 22.5 MeV in ^{28}Si which emit protons leaving the residual ^{27}Al mostly in the ground state or the few excited states available below 4 MeV. The 30-MeV spectrum does not show any additional structure, but the difference spectrum from the 22.5- and 30-MeV data reveals that, in this region, there is a strong photon absorption which leads to proton emission to form a continuous spectrum, leaving the residual ^{27}Al nuclei mostly in excited states in the neighborhood of 7 MeV. (Disser. Abstr.)

28277 SPECTROSCOPY OF THE N = 27 DOUBLY ODD NUCLEI THROUGH THE J-DEPENDENCE OF THE (^{3}He,t) REACTION. Bruge, G.; Bussiere, A.; Faraggi, H.; Kossanyi-Demay, P.; Loiseaux, J. M.; Roussel, P.; Valentin, L. (Centre d'Etudes Nucleaires, Saclay, France). Nucl. Phys., A129: 417-33(1969).

The doubly odd nuclei ^{48}Sc, ^{50}V, ^{52}Mn, and ^{54}Co were studied by the charge exchange reaction (^{3}He,t) on ^{48}Ca, ^{50}Ti, ^{52}Cr, and ^{54}Fe enriched targets. In addition to the analog state of the target ground state, a great number of low-lying energy levels were observed, especially those which can be described by the $[(f_{7/2})_p(f_{7/2})_n^{-1}]$ configuration. For these levels angular distributions from 10 to 70° c.m. were obtained. It was observed that these angular distributions show a typical pattern for each value of the total transferred angular momentum J as shown by levels of ^{48}Sc, ^{52}Mn, and ^{54}Co for which spins are already known. This property allowed J-values for the more excited levels to be proposed. Thus, most of the components of the $[(f_{7/2})_p(f_{7/2})_n^{-1}]$ multiplet have been identified in ^{48}Sc, ^{50}V, and ^{52}Mn. For ^{48}Sc, angular distributions are practically identical at 18.5 and 30.2 MeV. It seems that the (^{3}He,t) reaction at 30.2 MeV on N = 28 targets proceeds through an apparently quite simple mechanism. (auth)

28278 LEVELS OF ^{39}Cl STUDIED BY THE ^{40}Ar(d,^{3}He)^{39}Cl REACTION AT 52 MeV. Wagner, G. J. (Max-Planck-Institut fuer Kernphysik, Heidelberg); Kaschl, G. Th.; Mairle, G.; Schmidt-Rohr, U.; Turek, P. Nucl. Phys., A129: 469-80(1969).

Levels of ^{39}Cl were populated by the ^{40}Ar(d,^{3}He)^{39}Cl reaction at an incident energy of 52 MeV. A range of 7 MeV of final excitation was covered; 16 levels were observed, 14 of which were not known before. Spin and parity assignments to the majority of these levels were accomplished by a DWBA analysis of the angular distributions and by utilizing the j-dependence of the l = 2 angular distributions observed in the $^{32}S(d,^{3}He)^{31}P$ reaction. The $1d_{3/2}$ and $2s_{1/2}$ hole strengths are essentially concentrated in one single state each. These are considered as dominant 2p-3h states with respect to ^{40}Ca. The small energy gap of only 0.7 MeV between the $1d_{3/2}$ and $2s_{1/2}$ centers of gravity is understood from the properties of the s-f and d-f effective interactions. The observed l = 3 strength yields evidence for proton core excitations which are of comparable size to those in the calcium isotopes. Excitations of 2s protons into the f-shell contribute significantly. The $d_{5/2}$ hole strength is strongly fractionated with a center of gravity as low as 4.5 MeV of final excitation. (auth)

28279 POSSIBLE SPIN DEPENDENCE IN PROTON INELASTIC SCATTERING. Legg, J. C. (Kansas State Univ., Manhattan); Yntema, J. L. Phys. Rev. Lett., 22: 1005-8 (May 12, 1969).

An anomaly, apparently a final-state spin dependence, was observed in proton inelastic scattering from ^{63}Cu, ^{65}Cu, and ^{67}Zn. The excited-core model of inelastic scattering cannot produce such an effect. Indeed, no current theory of inelastic scattering based on the distorted-wave Born approximation can even qualitatively predict such an effect. (auth)

28280 CIRCULAR POLARIZATION OF THE GAMMA RADIATION OF ^{46}Sc. Pingot, O. (Centre de la Faculte Polytechnique de Mons, Belgium). Nucl. Phys., A129: 270-2(1969). (In French).

The $\beta-\gamma$ circular polarization correlation in the decay of ^{46}Sc was studied. The asymmetry parameter A found is 0.0843 ± 0.0030; the Fermi to Gamow–Teller matrix element ratio is 0.0015 ± 0.0050. (auth)

28281 GAMMA RAYS FROM ^{28}Al, ^{186} ^{188}Re, ^{233}Th, AND ^{233}Pa FOLLOWING NEUTRON CAPTURE. Hoekstra, Willem. Delft, Netherlands, Technische Hogeschool, 1969. 89p.

Thesis.

At the Reactor Institut in Delft (H.O.R.), a neutron capture gamma ray experiment was arranged at the tangential beam tube of the reactor. With the aid of the lithium-drifted germanium detector single gamma ray spectra have been measured for the reactions $^{27}Al(n,\gamma)^{28}Al$, $^{185,187}Re(n,\gamma)^{186,188}Re$ and $^{232}Th(n,\gamma)^{233}Th$. The reaction $^{35}Cl(n,\gamma)^{36}Cl$ was used for the calibration of the experimental arrangement. The results of the (n,γ) reactions on ^{232}Th and Re have such a complex character that coincidence measurements were necessary to make a decay scheme. The new experimental set-up, installed for this purpose, had not yet yielded results at the time of writing of this thesis. Yet, it was possible to propose values for the total decay energies of these reactions. It appeared that on the basis of the known data no reasonable Nilsson model assignment could be made for 22 m ^{233}Th, i.e. one of the product nuclei of these (n,γ) reactions. A possible explanation which assumed the existence of an isomeric state of similar half-life was disproved by experiments, showing no trace of any isomer with a half-life above 0.1 second. Therefore the decay of ^{233}Th and that of ^{237}Np, leading to the same final nucleus ^{233}Pa, was studied with Ge(Li) gamma counters, Si(Li) electron detectors, surface barrier alpha spectrometers and coincidence equipment. Interpretation of the results made possible a unique $\frac{1}{2}[6,3,1]$ assignment to 22 m ^{233}Th and indicated the existence of a $K = \frac{3}{2}$ band in ^{233}Pa; this band had a rather uncommon deformation resulting from Coriolis interaction with $K = \frac{1}{2}$ and $K = \frac{3}{2}$ bands. (auth)

28282 THE 17.5-MeV LEVEL FORM FACTOR OF THE NUCLEUS ^{28}Si. Gul'karov, I. S.; Afanas'ev, N. G.; Savitskii, G. A.; Khvastunov, V. M.; Shevchenko, N. G. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh., 14: 129-31(Jan. 1969). (In Russian).

The spectra are presented of inelastically scattered electrons with the giant resonance excitation in ^{28}Si. The form factor of the 17.5 ± 0.2-MeV level is determined. The transition to this level is shown to be that of the E1 type. The giant resonance shape changes greatly with the momentum transferred. (auth)

28283 NEW TECHNIQUE FOR THE PARTIAL WAVE ASSIGNMENT OF A SLOW NEUTRON RESONANCE. Asami, A.; Moxon, M. C.; Stein, W. E. (Atomic Energy Research Establishment, Harwell, Eng.). Phys. Lett., 28B: 656-8(Mar. 17, 1969).

From measurements of the energy dependence of interference effects in the angular distribution of the scattered neutrons in the region of the 1.15 keV resonance in ^{56}Fe, the neutron partial wave was found to have odd parity. (auth)

28284 A PROJECTED HARTREE–FOCK DESCRIPTION OF THE LOW-LYING TRIPLET IN ^{45}Ti. Johnstone, I. P. (Univ. of Maryland, College Park). Contract ORO-3765-17. Phys. Lett., 28B: 643-4(Mar. 17, 1969).

It is shown that a projected Hartree–Fock treatment with band mixing can account for the low-lying triplet recently observed in ^{45}Ti. (auth)

28285 SHELL-MODEL CALCULATION OF TRANSITION PROBABILITIES BETWEEN A = 31 EVEN-PARITY STATES. Glaudemans, P. W. M.; Dieperink, A. E. L.; Keddy, R. J.; Endt, P. M. (Univ., Utrecht). Phys. Lett., 28B: 645-7(Mar. 17, 1969).

Shell-model wave functions, incorporating particles in the $2s_{1/2}$ and $1d_{3/2}$ sub-shells and up to two holes in the $d_{5/2}$ sub-shell, were used to calculate M1 and E2 transition probabilities in ^{31}P, the log ft values for the ^{31}S and ^{31}Si beta decay, and the ^{31}P magnetic moment μ. Very good agreement with experiment is obtained for the largest M1 strengths, for the log ft values and for μ, if the isovector part of the matrix element is quenched, and for the E2 strengths (standard deviation 20%) if the average effective charge $\frac{1}{2}(e_p + e_n)$ is allowed to increase linearly with average excitation energy. All E2 transitions are highly fragmented, whereas the strong M1 transitions derive their strength from just one or two components. (auth)

28286 THE MAGNETIC MOMENT OF THE $\frac{7}{2}^-$ STATE AT 1.29 MeV IN ^{41}K. Bleck, J.; Haag, D. W.; Leitz, W.; Michaelsen, R.; Ribbe, W. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Phys. Lett., 28B: 651-2(Mar. 17, 1969).

The g-factor of the $\frac{7}{2}^-$ state in ^{41}K at 1.29 MeV has been measured with the spin precession method. The value found for the magnetic moment is $\mu = +4.41 \pm 0.05$ n.m. The measured half-life is $T_{1/2} = 7.3 \pm 0.2$ ns. (auth)

28287 EXCITATION OF GIANT RESONANCE IN Ni ISOTOPES BY MEANS OF HIGH ENERGY ELECTRONS. Gul'karov, I. S.; Afanas'ev, N. G.; Khvastunov, V. M.; Shevchenko, N. G.; Afanas'ev, V. D.; Savitskii, G. A.; Khomich, A. A. (Physical-Technical Inst., Kharkov). Yadern. Fiz., 9: 478-86(Mar. 1969). (In Russian).

The giant resonance in $^{58,60,64}Ni$ was investigated in the excitation energy region from 10 up to 30 MeV by means of the electrons with energies 150 to 200 MeV. The obtained form factor of the giant resonance in the ^{60}Ni nucleus is in agreement with the predictions of the dynamic collective model. Observed peaks in the low-energy part of the spectrum of the ^{60}Ni giant resonance confirm a necessity to account particle-hole states in the dynamic collective theory. The form factors of the giant resonances in the isotopes $^{58,60,64}Ni$ measured at the same momentum transfer, do not depend on A up to the experimental errors. (auth)

28288 REORIENTATION MEASUREMENTS IN ^{20}Ne AND ^{22}Ne. Schwalm, D.; Povh, B. (Univ., Heidelberg. Max-Planck-Institut fuer Kernphysik, Heidelberg. Phys. Lett., 29B: 103-4 (Apr. 14, 1969).

The static quadrupole moments of the first excited $J^{\pi} = 2^+$ states in ^{20}Ne and ^{22}Ne are deduced from measurements of the reorientation effect in Coulomb excitation with ^{32}S ions. The values obtained are $Q(2^+) = -0.27 \pm 0.11$ b and $Q(2^+) = -0.21 \pm 0.06$ b for ^{20}Ne and ^{22}Ne, respectively. (auth)

28289 THE SPIN, PARITY, AND LIFETIME OF THE 4.46 MeV STATE OF ^{32}S. Garvey, G. T.; Jones, K. W.; Carlson, L. E.; Robertson, A. G.; Start, D. F. H. (Oxford Univ.). Phys. Lett., 29B: 108-10(Apr. 14, 1969).

The 4.46 MeV levels in ^{32}S was found to have $J^{\pi} = 4^+$ and a lifetime of 0.13 ± 0.03 ps. The B(E2) extracted from this lifetime is compared with predictions of rotational and vibrational models. (auth)

28290 LIFETIMES OF LEVELS IN ^{23}Na BELOW 5 MeV. Durell, J. L.; Alderson, P. R.; Bailey, D. C.; Green, L. L.; Greene, M. W.; James, A. N.; Sharpey-Schafer, J. F. (Univ. of Liverpool). Phys. Lett., 29B: 100-2(Apr. 14, 1969).

The lifetimes of seven states in ^{23}Na were measured with the attenuated Doppler shift method. Transition strengths are compared to theoretical predictions where the levels are assumed to be members of either $K = \frac{3}{2}^+$, $\frac{1}{2}^+$ or $\frac{1}{2}^-$ rotational bands. (auth)

28291 EXCITATION FUNCTIONS FOR $^{48}Ca(d,p)^{49}Ca(0)$ IN THE RANGE $E_d = 3.0$ TO 5.5 MeV. Lacek, H.; Bakowsky, W.; Strohbusch, U. (Univ., Freiburg i. B.). Z. Phys., 223: 145-9 (1969).

Excitation curves for $^{48}Ca(d,p)$ $^{49}Ca(0)$ were measured at 12 angles in the energy region from 3.0 to 5.5 MeV to investigate the charge-exchange effect expected at the analogous (d,n) threshold opening at 4.3 MeV. A broad flat minimum is seen in the 165° excitation curve around this threshold which is, however, much less significant than the charge-exchange cusps observed in the A ≈ 90 mass region. More significant structure is seen at $E_d \approx 5$ MeV, which possibly may be connected with ^{48}Ca(4.611) core excitation or due to an intermediate state in ^{50}Sc. (auth)

Nuclear Properties and Reactions, A ≥ 90

Refer also to abstracts 26364, 26540, 27718, 27719, 27721, 27784, 28231, 28242, 28244, 28246, 28270–28272, 28281, 28326, and 28561.

28292 (AD–680259) DECAY PROPERTIES OF ^{133}Sb. Treytl, William J. (Naval Radiological Defense Lab., San Francisco, Calif.). Sept. 16, 1968. 28p. (USNRDL–TR–68–118). CFSTI.

Radiations from the decay of ^{133}Sb were studied with solid-state and scintillator γ and β detectors. Singles γ, γ-γ, and β-γ measurements were performed, and a decay scheme for ^{133}Sb was constructed consisting of levels at 0, 334, 979, 1152, 1679 and 2776 keV. Beta branches and log ft values were deduced. The Q_β for ^{133}Sb has been measured to be 3450 ± 200 keV. The decay scheme is interpreted according to single-particle shell model and quasiparticle-phonon coupling theory. Some γ rays were attributed to ^{132}Sb, principally one at 1024 keV which is probably the 2+ first excited level. (auth) (USGRDP)

28293 (BARC–362) ENERGY–ANGLE CORRELATION OF LONG RANGE ALPHA PARTICLES EMITTED IN THERMAL NEUTRON FISSION OF ^{235}U. Nadkarni, D. M. (Bhabha Atomic Research Centre, Bombay (India)). 1968. 17p. Dep.

The energy spectra of long-range alpha particles emitted at 90° and 0° (or 180°) with respect to the direction of fission-fragment motion were measured in the case of thermal neutron-induced fission of ^{235}U. These energy spectra were measured simultaneously using semiconductor detectors for detecting the long-range alpha particles and fission fragments. Significant differences in the characteristics of these spectra were observed. Using these data, the FWHM of the alpha–fission fragment angular correlation was computed for alpha particles of various energies, assuming the correlation function to be gaussian with its maximum value at 94°. The variation of the computed FWHM of the alpha–fission fragment angular correlation with alpha-particle energy shows features similar to those observed in the case of spontaneous fission of ^{252}Cf by Fraenkel. The present work indicates that very high energy LRA ($E\alpha > 26.5$ MeV) are emitted preferentially along the fragment direction. (auth)

28294 (BARC–363) YIELD OF K X RAYS EMITTED FROM ^{235}U FRAGMENTS. Kapoor, S. S.; Ramamurthy, V. S.; Zaghloul, R. (Bhabha Atomic Research Centre, Bombay (India)). 1968. 22p. Dep.

The yield of K x rays from different fragment masses was determined in the thermal neutron-induced fission of ^{235}U. The energies of the pairs of fragments were measured with two semiconductor detectors placed on either side of a thin ^{235}U foil. The K x rays from the light and the heavy groups of fragments were separated by measuring the x-ray energies with a 1-mm NaI(Tl) crystal. The fragment mass distributions in coincidence with the light group of K x rays, heavy group of K x rays, and the unbiased mass distributions were simultaneously recorded in different quarters of a 1024-channel analyzer memory. From these distributions, after suitable corrections for the background, x-ray detection efficiencies, and finite energy resolution effects, the number of x rays as a function of fragment mass was determined. The K x-ray yield per fission is found to be (0.08 ± 0.01) for the light fragment group and (0.30 ± 0.02) for the heavy fragment group. The gross features of the yield as a function of mass are similar to those observed earlier for emission from ^{252}Cf fragments. However, unlike the case of ^{252}Cf, for masses greater than 144 the striking increase in the yield was not observed. The present results are consistent with the interpretation that the x-ray yield depends both on the characteristics of the low-lying states and the initial spin of the fragments. (auth)

28295 (BMwF-FBK–68–46) GROUND–STATE AND SADDLE-POINT PROPERTIES OF HEAVY "NUCLEI FOR A DYNAMIC FISSION THEORY." Hasse, R. W. (Wuerzburg Univ. (West Germany). Physikalisches Institut). Sept. 1968. 26p. (In German). Dep.

Ground states and saddle points of the heavy elements thorium to fermium were calculated with a modified liquid–drop formula including curvature and shell–energy corrections. Intrinsic quadrupole moments and fission barriers were compared with experimental data. Relative moments of inertia at the saddle point were computed. Three degrees of freedom were allowed: elongation, asymmetry and constriction, which at the saddle point are equivalent to the three normal modes of oscillation: fission, asymmetry, and vibration. The normal stiffnesses and normal masses of these modes are presented. Fission–barrier curvatures were compared with those achieved by experiments. Statistics of the initial coordinates in the vicinity of the saddle were performed for low-energy fission of heavy elements. (auth)

28296 (JINR–P3–4354) ELASTIC NEUTRON SCATTERING BY MEDIUM AND HEAVY NUCLEI IN THE ENERGY RANGE 1 TO 40 keV. Aleksandrov, Yu. A.; Samosvat, G. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1969. 34p. (In Russian). Dep.

The technique and the measurement results of the angular distributions of 1 to 40 keV neutrons, scattered by the Sr, Mo, Rh, Cd, Sn, Sb, Te, I, La, Pb and Th nuclei are described. The method of obtaining the relative averaged differential scattering cross sections from the observed angular distributions of neutrons emitted from thick scatterers, is expounded. It is shown that for each element all the obtained information can be described by one parameter ω_1/E, where ω_1 is the coefficient for the first polynomial in the cross section expansion in the Legendre polynomials, and is the neutron energy. The contribution of the compound nucleus into the value ω_1 is analyzed and is shown to be small. The experimental results are compared with the calculations performed by the optical model of the nucleus, where good qualitative agreement is obtained by potentials describing other data on the neutron interaction with the nuclei. The results for La separate out of the whole picture for the coefficient ω_1 behavior with the change of neutron energies. (auth)

28297 (KFK–876) γ TRANSITIONS AND EXCITED STATES OF NEUTRON-DEFICIENT EVEN LEAD NUCLEI INVESTIGATED BY DECAY OF BISMUTH NUCLEI. Hanser, A. (Kernforschungszentrum, Karlsruhe (West Germany). Zyklotron-Laboratorium). Dec. 1968. 65p. (In German). Dep.

Gamma transition energies, relative gamma intensities, K conversion coefficients, and K/L conversion ratios were measured for the decay of the nuclei ^{202}Bi(1.6 h), ^{200}Bi (36 min), and ^{198}Bi (12 min) using semiconductor detectors. Coincidence relations of sufficiently strong transitions were investigated with NaI(Tl) detectors. The observed transitions were assigned, as far as possible, to the level schemes of the daughter nuclei ^{202}Pb, ^{200}Pb, and ^{198}Pb. The investigated Bi nuclides were produced through irradiation of Pb (enriched in ^{204}Pb) with 52-MeV deuterons or Tl with 104-MeV alpha particles and isolated by subsequent electromagnetic and chemical separation. (tr-auth)

28298 (LA–4085-tr)) INTERNAL-CONVERSION ELECTRONS OF ^{124}Sb. Grigor'ev, E. P.; Zolotavin, A. V.; Sergeev, V. O.; Sovtsov, M. I. Translated by Helen J. Dahlby (Los Alamos Scientific Lab., N. Mex.), from Izv. Akad. Nauk SSSR, Ser. Fiz., 32: 773-80(1968). 9p. Dep. CFSTI.

The conversion-electron spectrum of ^{124}Sb was studied with a magnetic β spectrometer. Measurement and stabilization of the spectrometer magnetic field were accomplished by the NMR method. The spectrometer was calibrated with the conversion electrons of ^{169}Yb. The level scheme for ^{124}Te was determined as well as internal conversion coefficients and multipolarities for γ transitions. (J.W.R.)

28299 (LA-DC–9763) NEUTRON AND GAMMA RADIATIONS FROM PURE ^{238}Pu. Bubernak, J.; Matlack, G. M.; Metz, C. F. (Los Alamos Scientific Lab., N. Mex.). [1968]. Contract W-7405-eng-36. 4p. (CONF-681101–19). Dep. CFSTI.

From International Conference on the Constructive Uses of Atomic Energy, Washington, D. C.

The neutron activity of ^{238}Pu was measured for high-purity Pu metal and for oxide and nitride compounds of Pu using a water-moderated BF_3 detector. High-resolution γ spectra were measured for the metal, and oxide, nitride, and fluoride compounds. (J.W.R.)

28300 (NP–17819, Chap.3.2) LOW-ENERGY NUCLEAR PHYSICS. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)). 5p.

The widths and spins of the 8.8- and 12.4-eV resonances in ^{235}U and the 2.4-eV resonance in ^{177}Hf were measured. An upper limit for the thermal neutron capture cross section of ^{241}Am was established, and the yields of As isotopes from thermal neutron fission of ^{235}U were investigated. The decay schemes of ^{104g,m}Rh were studied using Ge(Li) detectors. Three Ge(Li) detectors were prepared by drifting in a bath of boiling pentane. Projected Hartree–Fock calculations were performed for light nuclei. (D.C.W.)

28301 (RLO-2060-1) NUCLEAR CHEMISTRY PROGRESS REPORT. Loveland, Walter D. (Oregon State Univ., Corvallis). Mar. 1969. Contract AT(45-1)-2060. 34p. Dep. CFSTI.

Research carried out at Oregon State University in the period June 15, 1968 to March 15, 1969, is described. Work was done in nuclear fission data compilation, fission studies, cosmochemistry neutron beam extraction from the TRIGA reactor, and the theory of centrifugal stretching in nuclei. (J.W.R.)

28302 (SGAE-PH-78/1968) INVESTIGATION OF THE TRANSFER RATES OF ELECTROMAGNETIC TRANSITIONS BY MEASUREMENT OF THE LIFETIMES OF EXCITED ENERGY LEVELS AFTER NEUTRON CAPTURE. Nabielek, Heinz (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf. Physik-Institut). Nov. 1968. 98p. (In German). Dep.

Thesis.

The gamma-ray transition probability between nuclear states is expressed by transition matrix elements depending on the amplitudes and phases of the wave functions involved. Thus, the comparison of experimentally determined absolute gamma-ray transition probabilities with theoretical predictions is one of the most fruitful methods for testing nuclear models. For this purpose lifetime measurements in the nanosecond region of excited nuclear states were performed. The results are expressed in Weisskopf units. The nuclei selected for investigation were the odd-mass deformed nuclei ^{153}Sm, ^{163}Dy, ^{165}Dy, ^{167}Er, ^{169}Yb, and the odd-proton, odd-neutron nuclei ^{56}Mn, ^{198}Au. The neutron capture reaction was used for excitation. The lifetime measurements were performed by direct timing of a γ-γ cascade using scintillation detectors and fast photomultipliers. The electronic system consisted of a fast-slow coincidence system with time-to-amplitude converter and multi-channel-analyzer incorporated. The typical time resolution was of the order of one nanosecond. The measurements were evaluated by digital computer programs. (auth)

28303 (WAPD-TM-830) TRANSMISSION MEASUREMENT OF THE ^{252}Cf FISSION NEUTRON SPECTRUM (LWBR DEVELOPMENT PROGRAM). Green, L. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Mar. 1969. Contract AT(11-1)-Gen-14. 31p. Dep. CFSTI.

The spontaneous fission neutron spectrum from ^{252}Cf was measured using a highly accurate transmission method. An excellent fit to the data was computed assuming a Maxwellian spectrum shape with a temperature of 1.39 ± 0.04 MeV. The error includes contributions from uncertainties in cross sections and experimental statistics. In addition, all other possible sources of systematic error were investigated and found to be negligible. This value is in good agreement with earlier results at the low end of the range of measured values of the Maxwellian temperature. (auth)

28304 (WASH-1124) REPORTS TO THE AEC NUCLEAR CROSS SECTIONS ADVISORY COMMITTEE. Moore, M. S. (comp.) (Los Alamos Scientific Lab., N. Mex.). 1968. 244p. (EANDC(US)-111-U; INDC(US)-9-U; CONF-681046-). Dep. CFSTI.

From AEC Nuclear Cross Sections Advisory Committee Meeting, New York.

Research programs dealing primarily with neutron reactions and scattering and with neutron resonance parameters are summarized. Some investigations of charged-particle reactions and scattering, nuclear decay, and nuclear energy levels are also outlined. Developments in facilities and instrumentation are also reported. (D.C.W.)

28305 LOW-LYING EXCITED LEVELS IN ^{200}Hg. Sakai, Mitsuo (Tokyo Univ.). J. Phys. Soc. Jap., 26: 379-94(Apr. 1969).

Low-lying excited levels in ^{200}Hg were investigated with a Ge(Li) gamma-ray spectrometer and an internal conversion spectrometer. The spin and parity 2+ of the 1028.7-keV third excited level were confirmed, based on the internal conversion coefficient and K/L ratio of the transition from this level to the first excited 2+ state. Several new lines were found. A revised decay scheme was proposed. The experimental results showed that the nuclear structure of this nucleus can be understood fairly well with a model of two-proton holes coupled to harmonic surface vibrations. (auth)

28306 DESCRIPTION OF ENERGY LEVELS OF N = 88 NUCLEI. Sood, P. C. (Bhabha Atomic Research Centre, Bombay). J. Phys. Soc. Jap., 26: 1059(Apr. 1969).

It is shown that the rotational levels in N = 88 nuclei may be described with the centrifugal stretching model which is applicable to deformed nuclei. This implies that the idea of a sudden onset of deformation at N = 90 is invalid. (J.W.R.)

28307 COMPARISON OF REACTIONS INDUCED BY MEDIUM-ENERGY ^{3}He AND ^{4}He PARTICLES ON HEAVY NUCLEI. Scott, Nolie Edward. Lafayette, Ind., Purdue Univ., 1968. 142p.

Thesis.

Excitation functions were determined from threshold to 43 MeV for ^{181}Ta(α,xn) $^{185-x}$Re reactions; from threshold to 32 MeV for the reactions ^{181}Ta(^{3}He,xn) $^{184-x}$Re, ^{207}Pb(^{3}He,xn) $^{210-x}$Po, and ^{208}Pb (^{3}He,xn) $^{211-x}$Po with the exception of those reactions which produce ^{209}Po. Cross sections for the following reactions were determined for at least one energy: (α,p), (α,pn), (α,p3n), (α,2p) on ^{186}W; (^{3}He,α), (^{3}He,α2n) on ^{181}Ta; (^{3}He,p) (^{3}He,p2n), (^{3}He,2p), on ^{186}W; ^{185}Re(^{3}He,2p) + ^{187}Re(^{3}He,α); ^{209}Bi(^{3}He,pn). The sum of (α,xn) cross sections from this work and other experiments were shown to closely approximate the optical model reaction cross section. It was demonstrated that (α,xn) reactions on heavy nuclei at medium energies are very predominantly compound-nucleus in mechanism. The sum of (^{3}He,xn) cross sections were shown to account for approximately 50% of the optical model reaction cross section and these reactions have also been shown to result from statistical processes. Neutron emission was established as the primary mode of de-excitation of compound nuclei formed by ^{3}He particles on high-Z nuclei. At approximately equivalent excitation energies the charged-particle emission reactions were shown to be larger relative to neutron emission in ^{3}He-induced reactions than in α-induced reactions. Reactions produced by ^{3}He ions which result in the emission of charged particles were attributed to direct mechanisms or a combination of direct and statistical processes. (Disser. Abstr.)

28308 DELBRUECK SCATTERING OF 10.8-MeV γ RAYS. Jackson, H. E.; Wetzel, K. J. (Argonne National Lab., Ill.). Phys. Rev. Lett., 22: 1008-10(May 12, 1969).

The differential cross section for elastic scattering of 10.83-MeV photons by Pb and by U was measured for scattering angles between 20° and 150°. The elastic scattering was resolved from inelastic contributions for the first time. For scattering angles less than 45° this process is dominated by the Delbrück effect. (auth)

28309 A STUDY OF THE MAGNETIC DIPOLE MOMENTS OF ^{192}Ir AND ^{194}Ir AND THE DECAY SCHEME OF ^{192}Ir BY NUCLEAR ORIENTATION. Reid, P. G. E.; Sott, M.; Stone, N. J. (Mullard Cryomagnetic Lab., Oxford. Clarendon Lab., Oxford). Nucl. Phys., A129: 273-96(1969).

The hyperfine interactions of ^{192}Ir and ^{194}Ir present as dilute impurities in an iron lattice and their radioactive decay to ^{192}Os, ^{192}Pt, and ^{194}Pt, were investigated using the low-temperature nuclear orientation technique with high-resolution gamma-ray detectors. New gamma rays of 595, 683, and 848 keV were found in the ^{194}Ir spectrum and fitted into the existing level scheme. The magnitudes of the magnetic dipole moments were measured to be $|\mu| = 1.41 \pm 0.08$ n.m. for ^{192}Ir and $|\mu| = 0.37 \pm 0.04$ n.m. for ^{194}Ir. Beta decay matrix element ratios ($j_\beta = 1/j_\beta = 0$) were determined for the 669- and 252-keV transitions with $\Delta I = 0$ in the decay of ^{192}Ir. The E2/M1 mixing ratios δ were determined for the 604-keV ($\delta = -1.50 \pm 0.10$), 308-keV ($\delta = +7.3 \pm 0.2$), and 296-keV ($\delta = +15 \pm ^{10}_{5}$) gamma transitions in ^{192}Pt. These results are compared with appropriate theoretical calculations and experimental systematics. (auth)

28310 ELASTIC SCATTERING OF 12-MeV DEUTERONS ON EVEN RARE-EARTH NUCLEI. Christensen, P. R. (Univ. of Copenhagen); Berinde, A.; Neamu, I.; Scintei, N. Nucl. Phys., A129: 337-49(1969).

Elastic scattering differential cross sections for 12-MeV deuterons on 16 nuclei with $144 \leq A \leq 208$ were measured in a high-resolution experiment. The experimental results were analyzed in terms of the optical model. A systematic variation of the spherical optical-model parameters is explained in terms of the nuclear deformation by averaging a deformed optical potential over the nuclear volume. The optical-model parameters in this mass number region were obtained. (auth)

28311 SUM-PEAK COINCIDENCE STUDIES OF ^{175}Yb AND ^{177}Lu. Murty, V. R.; Jnanananda, Swami (Andhra Univ., Waltair, India). Indian J. Phys., 42: 362-71(June 1968).

The attenuation factors were determined from the adder and zero bias sum-peak coincidence scintillation spectra, recorded in the 4π geometry arrangement. With knowledge of the experimentally determined photopeak efficiencies, the fractional intensities for crossover and cascade were obtained for 396- and 251-keV levels in the decay of ^{175}Yb. In the case of ^{177}Lu the same were evaluated for the 208-, 250-, and 321-keV peaks obtained in the spectra. The crossover and cascade relative intensity was corrected for internal conversion and admixture of other multiples and compared with the values obtained from the unified model. Reasonable agreement is observed in both the isotopes. (auth)

28312 SINGLE-PARTICLE STRUCTURE IN THE LEAD REGION. Auerbach, N. (Massachusetts Inst. of Tech., Cambridge. Yale Univ., New Haven); Stein, N. Contract AT(30-1)-3223. Phys. Lett., 28B: 628-32(Mar. 17, 1969).

The single-particle structure in ^{209}Bi and ^{208}Pb was studied using the particle-core coupling model. The 4^+ core excitation of ^{208}Pb was found to be important for splitting the $3p_{1/2}$ single-proton state, and this explains the strong 3.64 and 4.43 MeV levels in ^{209}Bi. (auth)

28313 ISOSPIN EFFECTS IN ^{96}Zr(p,d)^{95}Zr, ^{96}Zr(p,p')^{96}Zr, AND ^{96}Zr(p,p)^{96}Zr. Michelman, L. S.; Bonner, T. I.; Kulleck, J. G. (Univ. of Texas, Austin). Phys. Lett., 28B: 659-60 (Mar. 17, 1969).

Excitation functions for ^{96}Zr(p,d)^{95}Zr(g.s.), ^{96}Zr(p,p_0)^{96}Zr and ^{96}Zr(p,p')^{96}Zr were taken near the ^{96}Zr(p,n)^{96}Nb threshold of the excited state which is the analog of ^{96}Zr(g.s.). All channels exhibit fluctuations. In addition the (p,d) reaction shows a broad anomaly. The fluctuations may be analog of unbound neutron p-states which produce the anomaly. (auth)

28314 AN ANOMALOUS ROTATIONAL BAND IN ^{161}Er. Hagemann, K. A.; Hjorth, S. A.; Ryde, H.; Ohlsson, H. (Research Inst. for Physics, Stockholm. Univ. of Stockholm). Phys. Lett., 28B: 661-3(Mar. 17, 1969).

Strong transitions within an anomalous rotational band were observed in the ^{160}Dy(α,3n)^{161}Er reaction. The $9/2^+$ state at 189 keV is proposed to be the lowest of the band, which is strongly mixed with the $1/2^+$[660] Nilsson orbital as the main component. (auth)

28315 PROBABILITIES OF ELECTRIC QUADRUPOLE TRANSITIONS IN NUCLEAR ROTATION-VIBRATION MODEL. Begzhanov, R. B.; Belen'kii, V. M. (Inst of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk, No. 4, 58-63(1968). (In Russian).

The probabilities of electric quadrupole transitions in the rotation-vibration nuclear model were calculated for E2 transitions, comparing the values obtained with published data. The results for E2 using R-V theory and considering the first three coupling coefficients and the wave function terms neglected by A. Faessler et al. (Nucl. Phys., 70: 33(1965)). Results were in closer agreement with experiment than those presented in previous papers. (R.V.J.)

28316 GAMMA-RAY TRANSITIONS FROM ISOBARIC ANALOG STATES TO LOW-LYING STATES IN ^{93}Tc. Ejiri, H.; Ferguson, S. M.; Halpern, I.; Heffner, R. (Univ. of Washington, Seattle). Phys. Lett., 29B: 111-13(Apr. 14, 1969).

The ^{92}Mo(p,γ) reaction shows strong γ-decays to low-lying single-proton states from the isobaric analogue state (IAS) of a single-neutron state. However no measurable γ-decays are observed to lower states from the IAS of a collective state. (auth)

28317 ANALYSIS OF NEUTRON FISSION OF ODD-EVEN NUCLEI ^{231}Pa, ^{237}Np, ^{241}Am. Vorotnikov, P. E. (Inst. of Atomic Energy, Moscow). Yadern. Fiz., 9: 538-41(Mar. 1969). (In Russian).

On the basis of analysis of cross sections of neutron interactions with nuclei ^{231}Pa, ^{237}Np, ^{241}Am it is shown that the states of the corresponding compound nuclei produced from capture of s and p neutrons have different characteristics. The fission widths of the ^{232}Pa and ^{238}Np states, which are produced by p-neutrons, appear by two orders of magnitude more than for the states produced through the capture of s-neutrons. The states of ^{242}Am produced from capture of p neutrons have anomalously small radiative width that relates them to the spontaneously fissible state of ^{242}Am. In the fission cross section of ^{231}Pa the quasistable states appear that are analogous to those noted before in neutron fission of even-even nuclei. (auth)

28318 EFFECTS OF MUTUAL SHIELDING ON RESONANCE INTEGRALS OF ^{235}U, ^{238}U, ^{239}Pu, AND ^{240}Pu BELOW 150 eV. Mizuta, Hiroshi; Kamei, Takanobu (Nippon Atomic Industry Group Co., Ltd., Kawasaki, Japan). J. Nucl. Sci. Technol. (Tokyo), 6: 194-202(Apr. 1969).

The results of some quantitative studies on resonance interference are presented. The calculations were performed on a FORTRAN IV program RICM2, which solves numerically the slowing down of neutrons over many resonance levels in a two region lattice, and gives reaction rates, average cross sections, and effective resonance integrals of the nuclides concerned. Three combinations of resonant nuclides, ^{235}U-^{238}U, ^{239}Pu-^{238}U and ^{239}Pu-^{240}Pu, were considered, in conjunction with three oxide fuel rod radii, 0.2, 0.5, and 2.0 cm, the moderator (light water) to fuel volume ratio being maintained constant at 2.0. An energy range below 150 eV was covered by the calculations. The effects of resonance interference were found to be appreciable in this energy range. (auth)

Nuclear Theory

Refer also to abstracts 27732, 27839, 28268, and 28295.

28319 (CEA-R-3662) SMOOTHING OF SPECTRA IN NUCLEAR PHYSICS. Mougel, Jean-Francois (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Dec. 1968. 32p. (In French). Dep.

A method for spectra smoothing, using local corrections, is described. Consequences of smoothing, relative to changes of area and first moments are studied. This method, referring to very simple computations, can be used on a small computer with good results. Examples on true nuclear spectra are given. (auth)

28320 (ITF-69-4) OSCILLATOR FUNCTIONS AND NUCLEAR MATTER. Filippov, G. F. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1969. 19p. (In Russian). Dep.

The technique of handling of basic wave functions of the system of N nucleons in the central-symmetrical "oscillator" field is described. A special attention is paid to the calculation of asymptotical by the number of nucleons values of different physical quantity. Oscillator wave functions are used to calculate the binding energy of "the nuclear matter." It gives the possibility of formulating a sufficient condition for the two-body potential under fulfillment of which "the nuclear matter" appears to be in a compressed state. (auth)

28321 (LA-4030) ANALYTICAL METHOD FOR UNFOLDING GAMMA-RAY SPECTRA. Sanders, W. M.; Holm, D. M. (Los Alamos Scientific Lab., N. Mex.). July 1968. Contract W-7405-eng-36. 110p. Dep. CFSTI.

An analytical method and a computer code are described for unfolding complex gamma-ray spectra obtained with Ge(Li) detectors. The computer code will analyze 20 independent regions in a spectrum, with up to 350 data points and 11 full-energy lines in each region. Gaussian and exponential functions represent the data analytically. The best least-squares values of the energy, area, and width can be obtained for each full-energy peak. This report discusses the analytical techniques used and outlines the use of the code. (auth)

28322 FRACTIONAL PARENTAGE COEFFICIENTS FOR THE NUCLEAR jj-COUPLING STATES. Horie, Hisashi; Oda, Takeshi (Tokyo Inst. of Tech.). Progr. Theor. Phys. (Kyoto), Suppl. Extra No., 403-21(1968).

The fractional parentage coefficients for the nuclear jj-coupling states of both protons and neutrons are discussed in the conventional shell theory. The fractional parentage coefficients are factorized into three parts, the first of which is simple, and for the second and the third factors detailed discussions are given. Necessary recursion formulas for calculating them are derived and the systematic procedure for the orthogonalization are found in the cases that more than one states with the same quantum numbers appear. (auth)

28323 SYSTEMATIC STRUCTURE-CHANGE INTO THE MOLECULE-LIKE STRUCTURES IN THE SELF-CONJUGATE 4n NUCLEI. Ikeda, Kiyomi; Takigawa, Noboru; Horiuchi, Hisashi (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), Suppl. Extra No., 464-75(1968).

The rotational bands with the diatomic-molecule-like structure in the self-conjugate 4n light nuclei, such as α-α, α-^{12}C, and α-^{16}O, appear systematically at near the threshold energy for the decay into the relevant subunit nuclei. The relations between the structure change into the molecule-like structure and the threshold energy for the decay into the subunit nuclei are discussed. According to this discussion, the diagram for the systematic structure changes into the molecule-like structures through the alpha particle release is presented as the function of the mass number and the energy. Upon this diagram the rotational bands with $K = 0^+$ in light 4n nuclei can be summarized. The order of the degree of the polarization toward the separation of the subunit nuclei for the diatomic molecule-like structure case is discussed qualitatively. (auth)

28324 BINDING ENERGY OF NUCLEAR MATTER BY THE HOLE LINE EXPANSION METHOD. Akaishi; Yoshinori; Nagata, Sinobu (Kyoto Univ.). Progr. Theor. Phys. (Kyoto), Suppl. Extra No., 476-88(1968).

The binding energy of nuclear matter was calculated by the hole line expansion method, where the one-body potential of particle states is given up and higher-order terms treated with the same number of hole lines as a whole. Using Hamada and Johnston (H-J) potentials, a one-boson-exchange type (OBEP) and a soft-core with OPEP-tail, the two- and three-body contributions were calculated. The two-body contributions were about 7 MeV (H-J) to 15 MeV (OBEP) and were found to be strongly dependent on the tensor-central ratio in the triplet-even state. The three-body contributions were estimated by solving off-energy-shell reference spectrum equations and Bethe-Faddeev type equations. They were repulsive for hard core potentials at the normal density and 1 to 4 MeV for H-J at the equilibrium density, $r_0 = 1.2$ fm. (auth)

28325 NOTE ON THE ROTATIONAL STATES IN LARGE SINGLE j-SHELL. Arima, Akito (Brookhaven National Lab., Upton, N. Y. State Univ. of New York, Stony Brook). Progr. Theor. Phys. (Kyoto), Suppl. Extra No., 489-94(1968).

Providing $j \gg 1$ and $J \ll 2j + 1$, it is proven that $H_{int} = -(U^{(2)} U^{(2)}) - 3(U^{(1)}U^{(1)}$ can commute approximately with $U^{(2)}$; $[H_{int}, U^{(2)}] \cong 0$. This is the simplest explanation of why the rotational state comes out in a large single j-shell under the quadrupole-quadrupole interaction $(U^{(2)}U^{(2)})$. (auth)

28326 ALPHA-PARTICLE TYPE FOUR-BODY CORRELATION AND ALPHA-PARTICLE REDUCED WIDTH IN HEAVY NUCLEI. Sasaki, Kiyoshi (Nihon Univ., Narashino, Japan); Suekane, Shota; Tonozuka, Isao. Progr. Theor. Phys. (Kyoto), Suppl. Extra No., 373-80(1968).

It is shown that a configuration in which the protons are excited from the ground-state configuration to the same orbit as the uppermost occupied orbit of neutrons and which has been neglected in the usual shell-model calculations contributes to α-particle type four-body correlations in heavy nuclei. It is noted that the excited new configuration enhances the four-body correlations when the effective interaction is attractive in the singlet even state and the condition is just in accord with that on the effective interactions to constitute α-cluster. If the low-lying configurations are included, then the α-decay reduced width of ^{212}Po becomes 30% larger than that for the conventional configuration-mixing calculations by Harada. (auth)

28327 REPULSIVE CORE OF EFFECTIVE $\alpha-\alpha$ POTENTIAL AND THE PAULI PRINCIPLE. Tamagaki, Ryozo (Kyoto Univ.). Progr. Theor. Phys. (Kyoto), Suppl. Extra No., 242-58(1968).

The $\alpha-\alpha$ interaction is a typical one as the interaction between composite particles. The origin of the repulsive core employed in phenomenological $\alpha-\alpha$ potentials was investigated in connection with the characteristic inner oscillation of the relative wave function which is attributed to the Pauli principle and the hard internal structure of the α particle. It is shown that the elimination of the redundant solutions in the S and D waves leads to a unique description of the inner oscillation and the outermost energy-independent node plays the role equivalent to the hard-core radius. Arguments are developed so that the logical consequences obtained are applicable to the interaction between the other composite particles. Validity of the effective $\alpha-\alpha$ potential and connection with two nucleon potentials are also discussed. The importance of the angular momentum dependence of the effective potential should be emphasized, because the structural repulsive core disappears beyond some critical value of angular momentum. (auth)

28328 ON THE FOUR-BODY CORRELATIONS IN LIGHT NUCLEI. REDUCTION OF THE EFFECTIVE INTERACTION DUE TO THE PAULI PRINCIPLE. Takada, Kenjiro (Kyushu Univ., Fukuoka). Progr. Theor. Phys. (Kyoto), Suppl. Extra No., 223-32(1968).

The effect of the reduction of the effective interaction on the energy eigenvalue of the four-body scattering mode, which is caused by the Pauli principle, is estimated. Relation between the magnitude of the reduction and the number of the single-particle states is obtained by using a two-level model. Using a simple schematic model, it is shown that the effect cannot be neglected when the four-body correlations are strong. In realistic problems for light nuclei, the effect should therefore be taken into account by introducing an appropriate parameter. (auth)

28329 TOWARD A UNIFIED MICROSCOPIC THEORY OF VIBRATIONAL AND ROTATIONAL MOTION IN EVEN NUCLEI. Marumori, Toshio (Hahn-Meitner-Institut fuer Kernforschung, Berlin); Yamamura, Masatoshi; Miyanishi, Yoshinao; Nishiyama, Seiya. Progr. Theor. Phys. (Kyoto), Suppl. Extra No., 179-89 (1968).

To better understand the relationship between the vibrational motion in even spherical nuclei and the rotational motion in even deformed nuclei, a new microscopic approach is proposed. The emphasis is put on the explanation of the basic idea. In order to illustrate the physical essence of the method without inessential complications, the single j-shell model with the "pairing plus quadrupole force" is adopted. (auth)

28330 FOLDY TRANSFORMATION IN THE π-NUCLEUS INTERACTION. Cheon, Il-tong (Kobe-Gakuin Univ., Japan). Progr. Theor. Phys. (Kyoto), Suppl. Extra No., 146-55(1968).

The expansion of the πN interaction was derived with respect to (f/M) whose coefficients are in a simple relation to each other and which may reproduce experiments. (auth)

28331 GENERALIZATION OF THE GOLDHABER-TELLER MODEL AND NUCLEAR PHOTO AND ELECTROEXCITATIONS. Fujii, Saburo (Nihon Univ., Tokyo). Progr. Theor. Phys. (Kyoto), Suppl. Extra No., 97-108(1968).

The Goldhaber-Teller model was generalized in order to interpret the observed gross structure in photo- and electroexcitations of light nuclei. A coupling between the isospin and spin-isospin modes was introduced under the requirements of the rotation, space reflection, and time-reversal invariances. It was considered that one of the two eigenmodes obtained should correspond to the giant resonance and another be responsible for the excitations at higher energies. Comparison with experiment for ^{16}O supports the generalized model. (auth)

28332 DEUTERON CLUSTERING IN NUCLEAR MATTER. Bando, Hiroharu (Kyoto Univ.); Kuriyama, Atsushi. Progr. Theor. Phys. (Kyoto), Suppl. Extra No., 69-79(1968).

In order to consider the problem of mutual transition between the shell structure and the cluster structure of nuclei, a model of nuclear matter was treated in which the deuteron is the most important unit of clustering. Hartree-Bogolyubov theory was applied to the problem of deuteron clustering of the whole system. The problem of a deuteron moving rapidly in nuclear matter was also treated. The many-body effects on the clustering is discussed in two points: the Pauli principle and the single particle potential. (auth)

28333 ODNOCHASTICHNYE UROVNI SFERICHESKIKH YADER. (Single-Particle Levels of the Spherical Nuclei). Fayans, S. A. Moscow, Institute of Nuclear Energy, 1968. 36p.

The Schroedinger equation with the Woods-Saxon potential was solved by numerical integration for the single-particle spectrum for spherical nuclei. The forms of the radial wave functions for the discrete and quasi-discrete spectrum are given. Tables are presented for the single-particle matrix elements and integrals for the product of four wave functions chosen by transition selection rules. (J.W.R.)

28334 INCLUSION OF A P_4 TERM IN THE DEFORMED SHELL-MODEL POTENTIAL. Nilsson, B. (Lund Inst. of Tech., Sweden). Nucl. Phys., A129: 445-68(1969).

The properties of a P_4-dependent deformed shell-model potential are investigated. Total energy as a function of deformation of some actinide nuclei is calculated from single-particle energies corresponding to this potential with pairing and Coulomb energy included. Equilibrium distortions are determined. The formation of a neckline near the fission point is indicated, but the volume conservation condition is found inadequate in the nuclear saddle-point region. (auth)

28335 FEATURES OF THE DAVYDOV MODEL. Abecasis, S. M. (Laboratorio de Radiaciones, Buenos Aires); Bosch, H. E.; Plastino, A. Nucl. Phys., A129: 434-44(1969).

A detailed study of the Davydov model emphasizes some special features which are of interest for obtaining a clear picture of the characteristics, merits, and range of applicability of the model. Although the discussion is quite general, special attention is given to the deformed heavy nuclei for which a microscopic description of their collective spectrum is not yet available. The results show that the parametrization of the model proposed is highly satisfactory. (auth)

28336 QUASI-ELASTIC HIGH-ENERGY ELECTRON SCATTERING ON LIGHT NUCLEI. Balashov, V. V.; Kabachnik, N. M.; Markov, V. I. (Moscow State Univ.). Nucl. Phys., A129: 369-87(1969).

The quasi-elastic electron scattering reactions (e,e'p) are considered within the framework of the distorted-wave impulse approximation. The energy spectra and distorted momentum distributions for the 1p-shell nuclei are calculated. The reaction (e,e'n) is discussed. The problem of channel coupling in the quasi-elastic scattering reactions is investigated. (auth)

28337 ELASTIC SCATTERING OF HIGH-ENERGY ELECTRONS AND CORRELATION STRUCTURE OF LIGHT NUCLEI. Ciofi degli Atti, C. (Istituto Superiore di Sanita, Rome). Nucl. Phys., A129: 350-68(1969).

The scattering of high-energy electrons was analyzed in Born approximation with the aim of extracting new information on nuclear structure, particularly on correlation structure of light nuclei. For this purpose, the nuclear charge density was described by means of Jastrow-type determinants, thus taking into account correlations at small internucleon separations. The effect of introducing state-dependent potential wells was examined. The results show that the introduction of correlations is the only way of explaining the experimental data on ^{4}He and ^{6}Li and that for ^{12}C and ^{16}O the theoretical predictions agree quite well with experiment. The importance of considering higher momentum transfers, where the models considered give results which are very well distinguished from the predictions of the independent-particle shell-model, is pointed out. The charge density was calculated and both the values of the rms radii, and the "healing distance" for the 1s state wave function of relative motion are given. It is stressed that the main effect of correlations is a strong reduction of the central part of the charge density. The necessity of relating the obtained results with the ground state energy and with experiments which are connected with the two-body density matrix is pointed out. (auth)

28338 POLARIZATION OF SPIN-½ PARTICLES ELASTICALLY SCATTERED BY STRONGLY ABSORBING TARGETS. Abul-Magd, A. Y. (Cairo Univ.). Nucl. Phys., A129: 331-6 (1969).

Using the eikonal approximation, the polarization of strongly absorbed elastically scattered spin-½ particles is considered, and a closed-form expression is obtained by introducing Blair's sharp cut-off assumption and some other simplifying approximations. (auth)

28339 NUCLEAR CHARGE DISTRIBUTION IN FISSION. Mukherji, Shankar (Indian Inst. of Tech., Kanpur). Nucl. Phys., A129: 297-304(1969).

A new prescription has been formulated for calculating the most probable charge Z_p associated with a given heavy fragment from the thermal neutron induced fission of ^{235}U. This follows from the observation that a plot of the independent fractional chain yields of the heavy fission fragments against their N/Z (neutron to proton ratio), yields a single parabola with the peak at $N/Z = 1.587 \pm 0.005$. The independent fractional chain yield data from the thermal-neutron induced fission of ^{233}U and ^{239}Pu and the spontaneous fission of ^{252}Cf conform well to this curve. Available experimental data on Z_p in the case of ^{252}Cf are in excellent agreement with the present calculations and are in disagreement with those calculated by the postulates of unchanged charge distribution and maximum energy release. (auth)

28340 THE S' STATE IN THE TRI-NUCLEON AND NUCLEON-TRANSFER REACTIONS. Lim, T. K. (Florida State Univ., Tallahassee). Nucl. Phys., A129: 259-69(1969).

The normalization constant N, which is an essential quantity in the DWBA analysis of single- and two-nucleon transfer reactions, is evaluated for (^{3}He,d) and (^{3}H,d) stripping reactions. A velocity-dependent nucleon–nucleon potential and a $^2S_{1/2}$ tri-nucleon wave function, which includes a state of mixed symmetry, are used. Despite the smallness of its probability (taken to be 2% to allow for D-state contributions), the S' state gives rise to large corrections in the value of N as well as the binding energy and the Coulomb energy of the three-nucleon system. The potential and three-body wave function are also used to investigate the relative amplitudes for singlet and triplet spin transitions in (^{3}H,p) reactions. A comparison is made between the results, those of Bassel and Rook, and experiment. (auth)

28341 SIMPLE MODEL EXPLANATION OF SHELL EFFECTS IN NUCLEAR FISSION. Dickmann, Friedrich (Kernforschungszentrum, Karlsruhe, Ger.); Dietrich, Klaus. Nucl. Phys., A129: 241-58(1969).

It is shown that shell effects on the deformation energy of fission fragments as derived from Nilsson potentials can account for the observed variation of the kinetic and excitation energy of the fragments as a function of mass. A simple static model of two tangent fission fragments is used, the scission point being determined by the requirement that the sum of deformation energies and the mutual Coulomb repulsion should be a minimum. (auth)

28342 CLASSIFICATION OF THE EXCITED STATES IN LIGHT NUCLEI. I. REDUCTION OF THE IRREDUCIBLE REPRESENTATION OF THE ORTHOGONAL GROUP O_{n-1} TO THE REPRESENTATIONS OF THE SYMMETRICAL GROUP S_n. Vanagas, V.; Sabalyauskas, L. Yu. (Inst. of Physics and Mathematics, Vilnyus, USSR). Liet Fiz. Rinkinys, Liet. TSR Mokslu Akad. Liet. TSR Aukst. Mokyklos, 8: No. 1-2, 77-86(1968). (In Russian).

The method of classification of the excited states in the light nuclei using the chain of subgroups $U_{3(n-1)} \supset U_3 \times U_{n-1}$; $U_{n-1} \supset O_{n-1} \supset S_n$ is discussed. The recurrent way of the reduction of irreducible representations for the orthogonal group O_{n-1} to the symmetrical subgroup S_n is proposed. Concrete formulas for such a reduction in case of the representations of O_{n-1} group characterized by Young tables with the partition of numbers no more than seven are obtained. (auth)

28343 CLASSIFICATION OF THE EXCITED STATES IN LIGHT NUCLEI. II. STATES IN p- AND sd-SHELL NUCLEI. Sabalyauskas, L. Yu; Vanagas, V. V. (Inst. of Physics and Mathematics, Vilnyus, USSR). Liet. Fiz. Rinkinys, Liet. TSR Mokslu Akad., Liet. TSR Aukst. Mokyklos, 8: No. 1–2, 87-95 (1968). (In Russian).

The features of the classification of the excited states in p- and sd-shell nuclei using the chain of subgroups $U_{3(n-1)} \supset U_3 \times U_{n-1}$; $U_{n-1} \supset O_{n-1} \supset S_n$ are discussed. The characteristics of the orthogonal group O_{n-1} in the wave function are shown to be important only in the excited states with the number of quanta by two, three, etc., more than that in the ground state. The full classification of the states for all p- and sd-shell nuclei with the number of quanta by one more than that in the ground state is presented. (auth)

28344 CHANGE OF NUCLEAR CHARGE RADII BY SINGLE PARTICLE EXCITATIONS IN THE RARE EARTH REGION. Speth, J. (Technische Hochschule, Munich). Phys. Lett., 28B: 625-7(Mar. 17, 1969).

Changes of nuclear charge radii of some odd-even nuclei in the rare earth region are calculated within the frame work of the theory of finite Fermi systems of Migdal. (auth)

28345 ANALYSIS OF INELASTIC PROTON SCATTERING DATA. Tibell, G. (Uppsala Univ.). Phys. Lett., 28B: 638-42 (Mar. 17, 1969).

A simple method for analysing the small-angle part of the angular distributions obtained in measuring the differential cross sections for inelastic proton scattering is discussed. Data from (p,p') work at 185 MeV are shown as examples. (auth)

28346 EFFECT OF PHASE-SPACE VOLUME ON CHARACTERISTICS OF FRAGMENTATION. Milovanov, V. P. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz., 9: 544-51(Mar. 1969). (In Russian).

The effect of the phase-space volume on fragmentation is considered. Calculated dependences of the cross section on the energy and multiplicity as well as the angular and energy distributions are presented. The calculations are compared with experiment. The disagreements are discussed. (auth)

28347 ROLE OF QUASI-STATIONARY STATES IN NUCLEAR FISSION. Geilikman, B. T. Yadern. Fiz., 9: 535-7(Mar. 1969). (In Russian).

It is shown that presence of quasi-stationary levels in the potential well for the fission degree of freedom must result in appearance of a number of maxima on the fission cross section curve in the underbarrier region that are observed in experiments. (auth)

28348 MECHANISM OF INTERACTION OF FAST DEUTERONS WITH NUCLEI. Barashenkov, V. S.; Gudima, K. K.; Toneev, V. D. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 9: 528-34(Mar. 1969). (In Russian).

A method is proposed to calculate inelastic collisions of deuterons with nuclei. The calculations are performed by means of the Monte-Carlo method with account of the Coulomb and diffractional disintegrations of the deuteron. The results of the calculations are in good agreement with the experiment. (auth)

28349 UNIFIED MICROSCOPIC APPROACH TO THE VIBRATIONAL AND ROTATIONAL MOTION IN EVEN NUCLEI. Marumori, T.; Yamamura, M.; Miyanishi, Y.; Nishiyama, S. (Kyushu Univ., Fukuoka. Kyoto Univ.). Yadern. Fiz., 9: 501-6(Mar. 1969). (In Russian).

With the purpose to make a bridge between the vibrational motion in even "spherical" nuclei and the rotational motion in even "deformed" nuclei, a new microscopic approach is proposed. (auth)

28350 NOTE ON AN ERROR IN A TABLE OF THEORETICAL COEFFICIENTS FOR GAMMA–GAMMA DIRECTIONAL CORRELATIONS. Whitlock, L. C.; Hamilton, J. H.; Ramayya, A. V. (Vanderbilt Univ., Nashville). Nucl. Instrum. Methods, 70: 355-6 (May 1, 1969).

Theoretical values of Taylor and McPherson for gamma-gamma directional correlation coefficients for a 2(2,3)4(2)2 cascade have been found to be in error. A correct table of values is given. (auth)

28351 INTERNAL BREMSSTRAHLUNG AND THE POLE MECHANISM OF DIRECT NUCLEAR REACTIONS. Janouch, F.

(International Centre for Theoretical Physics, Trieste, Italy); Mach, R. Phys. Lett., 29B: 79-82(Apr. 14, 1969).

The internal bremsstrahlung from direct nuclear reactions in the pole approximation is calculated. The methods of identifying the direct reaction mechanisms are discussed. (auth)

28352 SPIN DEPENDENT OPTICAL POTENTIAL FOR DEFORMED NUCLEI. Rook, J. R. (Nuclear Physics Lab., Oxford). Phys. Lett., 29B: 86-7(Apr. 14, 1969).

The Born approximation was used to compare the full spin dependent potential for a deformed nucleus with the simple spin-orbit term. For large momentum transfers the latter is a good approximation but not otherwise. (auth)

28353 TENSOR POTENTIAL OF THE OPTICAL MODEL FOR DEUTERONS. Raynal, J. (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). Phys. Lett., 29B: 93-4(Apr. 14, 1969). (In French).

It is shown that the phenomenological tensor coupling, extracted from an optical model analysis of d-Ca elastic scattering by Schwandt and Haeberli, is in good agreement with the tensor coupling derived from a nucleon-nucleus potential and the intrinsic wave function of the deuteron. (auth)

REACTOR TECHNOLOGY

Commercial Power Reactors

Refer also to abstracts 26618 and 28449.

28354 (AERE-Trans-1112) WATER CONTROL AND THE PREVENTION OF WATER AND STEAM RADIOLYSIS AT THE BELOYARSK NUCLEAR POWER STATION. Kot, A. A.; Levich, A. A.; Shchapov, G. A.; Gruzdev, N. I.; Lesunov, I. P. Translated by E. F. Towndrow (Atomic Energy Research Establishment, Harwell, Eng.), from Elek. Sta., 39: No. 1, 39-41(1968). 6p. Dep. CFSTI. UK 1s. 9d.

The second unit of this station is based on a once-through system using superheated steam in the heating channels of the reactor. As a result, the problems of water control and the suppression of water and superheated steam radiolysis become complicated compared with the first two-circuit unit. The suppression of water radiolysis with hydrogen takes place in the reactor itself, before the drum separator. If molecular oxygen is present in the circuit water the suppression of radiolysis by hydrogen is not appreciable, even on increasing the hydrogen content in the circuit steam to 88 ml/kg. Molecular oxygen is removed from the circuit water by adding hydrazine hydrate. If molecular oxygen is absent in the circuit, a hydrogen concentration in the circulation water of ca. 1 to 2 ml/kg is sufficient to suppress the radiolysis of water in the reactor, the residual oxygen content in the circulation water (after the main circulating pumps) not exceeding 0.02 to 0.03 mg/kg. The radiolysis of steam may be suppressed with hydrogen. For a hydrogen content of ca. 40 to 45 ml/kg in the steam the concentration of radiolytic oxygen in the superheated steam is reduced to 0.03 mg/kg for channel steam pressures of 8.5 and 6.5 MN/m^2 at the inlet and outlet, respectively. (auth) (UK)

28355 (APDA-CFE-27) COMPILATION OF CURRENT TECHNICAL EXPERIENCE AT ENRICO FERMI ATOMIC POWER PLANT, NOVEMBER 1968. Costello, R. H. (Atomic Power Development Associates, Inc., Detroit, Mich. Power Reactor Development Co., Detroit, Mich. Detroit Edison Co., Mich.). Contract AT(11-1)-865. 38p. Dep. CFSTI.

Locating a second Zr segment which was not fastened to the south sector of the conical flow guide is described. The melting of the fastening Zr screwheads by an arc-melt tool is also described. A vacuum cleaning system for removing debris from the core inlet plenum is illustrated. A description of the Na primary system service flow diagram is presented. Analysis of primary Na valve bellows failures is included. Maintenance is described. (D.C.C.)

28356 (DOCKET-50266-9) POINT BEACH NUCLEAR PLANTS, UNITS 1 AND 2. Application for Operating Licenses. (Wisconsin Electric Power Co., Milwaukee. Wisconsin Michigan Power Co., Appleton, Wis.). Mar. 1969. 54p. (DOCKET-50301-6). Dep. CFSTI.

The Directors and Principal Officers of the Wisconsin Electric Power Company and the Wisconsin Michigan Power Company, owners of Point Beach Power Reactors, Units 1 and 2, are listed. Use of the facilities is briefly described. Financial qualifications and technical qualifications are presented. The 1968 Annual Reports for both companies are included. (M.L.S.)

28357 (DOCKET-50266-10) POINT BEACH NUCLEAR PLANT, UNIT NO. 1 AND 2. Final Facility Description and Safety Analysis Report, Volume 1. (Wisconsin Electric Power Co., Milwaukee. Wisconsin Michigan Power Co., Appleton, Wis.). Mar. 14, 1969. 357p. (DOCKET-50301-7). Dep. CFSTI.

Final design and safety analysis information on the Point Beach Power Reactors, Units 1 and 2, is given under the following broad topics: Introduction and Summary; Site and Environment; Reactor; and Reactor Coolant System. (M.L.S.)

28358 (DOCKET-50266-11) POINT BEACH NUCLEAR PLANT, UNIT NO. 1 AND 2. Final Facility Description and Safety Analysis Report, Volume 2. (Wisconsin Electric Power Co., Milwaukee. Wisconsin Michigan Power Co., Appleton, Wis.). Mar. 14, 1969. 485p. (DOCKET-50301-8). Dep. CFSTI.

Final design and safety analysis information is given on Point Beach Power Reactor, Units 1 and 2, under the following broad topics: Containment System; Engineered Safety Features; and Instrumentation and Control. (M.L.S.)

28359 (DOCKET-50266-12) POINT BEACH NUCLEAR PLANT, UNIT NO. 1 AND 2. Final Facility Description and Safety Analysis Report, Volume 3. (Wisconsin Electric Power Co., Milwaukee. Wisconsin Michigan Power Co., Appleton, Wis.). Mar. 14, 1969. 423p. (DOCKET-50301-9). Dep. CFSTI.

Final design and safety analysis information is given on Point Beach Reactor, Units 1 and 2, under the following broad topics: Auxiliary and Emergency Systems; Electrical Systems; Steam and Power Conversion Systems; Waste Disposal and Radiation Protection; Conduct of Operations; and Initial Tests and Operations. (M.L.S.)

28360 (DOCKET-50266-13) POINT BEACH NUCLEAR PLANT, UNIT NO. 1 AND 2. Final Facility Description and Safety Analysis Report, Volume 4. (Wisconsin Electric Power Co., Milwaukee. Wisconsin Michigan Power Co., Appleton, Wis.). Mar. 14, 1969. 375p. (DOCKET-50301-10). Dep. CFSTI.

Final safety analyses are detailed for the Point Beach Power Reactor, Units 1 and 2. Appendices to the Final Safety Analysis Report include: design criteria for structures and equipment, a functional evaluation of the components of the shared systems, and an evaluation of the efficiency of the containment spray system for iodine removal. (M.L.S.)

28361 (GAMD-8212) INSPECTION OF THERMAL BARRIER IN THE PEACH BOTTOM REACTOR VESSEL AT 168 AND 300 EFPD. Hildebrand, J. F. (Gulf General Atomic, Inc., San Diego, Calif.). Mar. 31, 1969. Contract AT(04-3)-314. 31p. Dep. CFSTI.

Inspection procedures and photographic analysis of the thermal barrier after 168 and 300 equivalent full-power days are presented. Results show that the thermal barrier is still in excellent condition. (D.C.C.)

28362 (NAA-SR-12445) PIQUA NUCLEAR POWER FACILITY REACTOR OPERATIONS ANALYSIS PROGRAM. Semiannual Progress Report No. 9, July 1-December 31, 1966. (Atomics International, Canoga Park, Calif.). May 1, 1969. Contract AT(04-3)-701. 113p. Dep. CFSTI.

A review of the operations and maintenance requirements during July to December 1966 is presented. System modifications are described. Coolant chemistry analysis is outlined. Moderator deposit sampling and testing are described. (D.C.C.)

28363 (NAA-SR-12516) SAFETY EVALUATION OF PNPF MODIFICATIONS. Huntsinger, M. (ed.); Hart, R. S. (Atomics International, Canoga Park, Calif.). May 1, 1969. Contract AT(04-3)-701. 344p. Dep. CFSTI.

The safety aspects of the restart and continued operation of the Piqua Nuclear Power Facility (PNPF) after the completion of certain system modifications are evaluated. These modifications primarily include changes in the fuel assembly structural details to greatly increase the flow of organic fluid in the moderator regions of the reactor, and revisions to the control rod drive circuitry. The new moderator hydraulic dynamics which result from the fuel assembly modifications are expected to greatly reduce the in-core deposition of carbonaceous material experienced previously. The modifications to the control rod drive circuitry will increase its overall operational reliability. The results of investigative studies pertaining to the accumulation of carbonaceous deposits in organic cooled reactor systems and their relationship to certain reactivity effects experienced in the initial operation of the PNPF are also presented. The basic conclusion reached is that while substantial system modifications are being made, the overall safety of the plant is not significantly affected, and that the safety analysis and conclusions of the original safeguards report remain valid and unchanged. (auth)

28364 CONSTRUCTION OF THE PRIMARY CONTAINMENT VESSEL. Hamada, Kunio (Hitachi Ltd., Tokyo). Karyoku Hatsuden, 20: 66-70(Jan. 1969). (In Japanese).

Manufacture of the primary containment vessel for No. 1 plant in Fukushima nuclear power station of Tokyo Electric Power Co. was started in workshops in June 1967, and the vessel was successful in the final pressure and leak tests in June 1968, thus the home production technique for the primary containment vessel was established. The primary containment vessel consists of a bottle shaped dry well containing the reactor pressure vessel and the recirculating system and a doughnut shaped torus filled with water for condensing steam in emergency state. It must be guaranteed sufficient tightness to prevent outward discharge of radioactive substances. Construction of the primary containment vessel makes one of critical paths in the whole reactor plant construction, therefore reduction of the construction time for the vessel is important. The manufactured primary containment vessel was assembled temporarily in the workshop, and afterwards it was divided in 1000 parts and transported to the construction site. After the assembling was finished, the pressure test by 1.15 times design pressure and the leak test by the design pressure were carried out. Weight of the primary containment vessel is more than 1200 tons, diameter of the torus is 29.57 m, the design internal pressure is 4.35 kg/cm^2 G, the external pressure is 0.14 kg/cm^2 G, the design temperature is 138°C, and the main structural materials are A212-B and A300 steels. (NSA of Japan)

28365 25 MW SCHLESWIG–HOLSTEIN NUCLEAR POWER PLANT (GEESTHACHT II). Boehm, E.; Ehret, A.; Geppert, H.; Hauck, W.; Kueper, K. D. (Gutehoffnungshuette, Sterkrade AG (GHH), Oberhausen, Ger.). Kerntechnik, 11: 69-76(Feb. 1969). (In German and English).

The Geesthacht Power Reactor (KSH) is described; design and operations characteristics are tabulated; cutaways show the primary system and steam system. Core design, operation, and control are discussed. (M.L.S.)

28366 PERFORMANCE OF HIGH-TEMPERATURE REACTOR AND HELIUM TURBINE. Bammert, K.; Krey, G.; Kueper, K. D. (Technische. Univ., Hanover). Kerntechnik, 11: 77-87(Feb. 1969). (In German and English).

The control of a nuclear power plant with high-temperature reactor and He turbine, its part-load behavior, and the control action are described. The special cases of reactor scram, shutdown of the turbine and load release as well as starting up and turning off of the plant are taken into consideration. The investigations have shown that the approved control device of the closed-cycle air turbine can be adopted largely for the control of the He turbine with high-temperature reactor. (auth)

28367 THE FUEL ELEMENT OF THE GEESTHACHT KSH REACTOR. Klusmann, A.; Rotterdam, R.; Jaspers, G. (Gutehoffnungshuette Sterkrade AG(GHH), Oberhausen, Ger.). Kerntechnik, 11: 92-8(Feb. 1969). (In German and English).

GHH is building a 25 MW high-temperature nuclear plant with a helium turbine in a direct cycle near Hamburg. The reactor core and the graphite fuel rods of this plant are described. The heavy metal (100 kg of 90% enriched uranium, 1000 kg of thorium) is incorporated in graphite containers as bonded coated particle fuel with porous oxide kernels and composite pyrocarbon and silicon-carbide coatings. The particle concept is described and the choice of graphite explained. The expected fuel element performance under normal and accident conditions is discussed. The specified fission-product release rates of the core for this first nuclear plant with a helium turbine are given. (auth)

28368 HIGH-TEMPERATURE GAS COOLING FOR FAST BREEDERS. Donne, M. Dalle; Eisemann, E.; Thuemmler, F.; Wirtz, K. (Kernforschungszentrum, Karlsruhe, Ger.). Kerntechnik, 11: 99-104(Feb. 1969). (In German and English).

The main problem for the development of gas cooled fast reactors is a reliable fuel element. Presently three possibilities for high temperature fuel design are discussed. All these fuels would allow gas outlet temperatures above 720°C, which allows the use of a direct gas turbine cycle with a net plant efficiency above 40%. In all cases the coolant pressure is considerably higher than the pressure normally used in thermal gas cooled reactors. The special safety aspects that appear in connection with gas cooled fast reactors are briefly discussed. 16 references. (auth)

28369 GAS-COOLED REACTORS WITH GAS-TURBINES USING HELIUM, NEON, OR CARBON–DIOXIDE. Dibelius, G.; (Technische Hochschule, Aachen); Foerster, S. Kerntechnik, 11: 105-10(Feb. 1969).

Gas turbine cycles and their components for various types of gas cooled reactors using different gases are compared. As reactors the Advanced Gas cooled Reactor, the High Temperature Reactor and the Fast Reactor are considered. As working fluid He, Ne, or CO_2 are used. The analysis is aimed at finding the best suited working fluid for the cycle in each case of reactor type and the most favorable cycle data for the lowest generating costs. Within the optimizing calculations the cycle data are varied and the corresponding heat exchanger surfaces as well as the main dimensions of the turboset are determined. From the costs for these components together with the fuel cycle costs, a representative part of the generating costs can be estimated. The mininum of the generating costs is taken as criterion for the choice of the cycle data and the plant components. The comparison of results shows for He and Ne only small differences in the partial generating costs. However, for He the heat exchangers are smaller and the turbines somewhat longer than for Ne. Therefore He seems to be more suitable as a working fluid for a non-integrated plant design, where larger equipment can be accommodated, while neon particularly at high pressures is attractive for an integrated plant design where little space for the turbines is available. For CO_2 similar characteristics are found as for Ne; however, it can only be used at a lower temperature level. 11 references. (auth)

28370 ATUCHA NUCLEAR POWER STATION. Herzog, Gerold; Sauerwald, Karl J. At. Strom, 15: 53-63(Apr. 1969). (In German).

A description of the site for the Atucha power reactor is given; the general layout of the plant is shown. The reactor pressure vessel, core, control rods and control system, cooling systems, and steam and power conversion systems are described; design and operations parameters are tabulated. (M.L.S.)

28371 THE PLANNING OF OPTIMUM BUILDING SEQUENCES FOR CONVENTIONAL POWER STATIONS, AND NUCLEAR POWER STATIONS. Bauer, Helmut; Theilsiefje, Klaus. At. Strom, 15: 32-8(Feb.-Mar. 1969). (In German).

A principle for optimum possible development of interconnected power systems is described. The aim is the determination of the construction sequences for different types and sizes of machines to give the most favourable cost. How system reliability is to be determined is first shown. Then there is a short discussion of plans for maintenance. In the main part the more exact description is given of the selective principle in development planning. It is shown how the reserve power and its cost evaluation can be compared with the cost of losses during failures. Finally an example of planning is explained, together with the determination of the optimum constructional sequence for the different types of machine, together with calculations. The displacement effect is also discussed. (auth)

28372 TSURUGA ATOMIC POWER STATION AND THE PRESENT STATE OF CONSTRUCTION. Hirakawa, Takao (Japan Atomic Power Co., Tokyo). Karyoku Hatsuden, 19: 1283-8(Dec. 1968). (In Japanese).

The Tsuruga Power Reactor is described. Topics discussed include: alterations in the facilities (reactor-core sprays, high-pressure water injection, reactor safety valves, and diesel engine generators); and the present state of construction (ground leveling and civil engineering, installation of the containment vessel, construction of the housing structures, building of the reactor pressure vessel, and installation of the instruments and pipings). (NSA of Japan)

28373 MIHAMA ATOMIC POWER STATION AND ITS CONSTRUCTION. Hamaguchi, Sunichi. Karyoku Hatsuden, 19: 1267-82(Dec. 1968). (In Japanese).

The Mihama Power Reactors, Unit 1 and Unit 2 are described. Topics discussed include: reactor plants, safety designs (safety devices, and anti-earthquake designs), turbo-generators, instrumentations and controls, waste disposals, radiation control, and the state of constructions. (NSA of Japan)

28374 THE PRESENT AND FUTURE OF THE FUKUSHIMA ATOMIC POWER STATION. Inoue, Kazuo (Tokyo Electric Power Co., Inc.). Karyoku Hatsuden, 19: 1256-66(Dec. 1968). (In Japanese).

Information concerning the Fukushima Power Reactor Unit 2 is presented. Topics discussed include: the method of control for BWR turbines, and stainless steels for the pressure vessel. Construction of the reactor containment vessel for the Fukushima Power Reactor Unit 1 is described. (NSA of Japan)

28375 PRESTRESSED CONCRETE PRESSURE VESSELS. Arthur, I. P. (Gulf General Atomic Inc., San Diego, Calif.). Chem. Engr. Progr., 65: No. 5, 84-8(May 1969).

Characteristics of prestressed concrete pressure vessels are reviewed. The development programs and progress on the Fort St. Vrain Power Reactor prestressed concrete pressure vessel are described. 4 references. (D.C.C.)

28376 DIGITAL COMPUTER APPLICATIONS FOR DATA PROCESSING OF NUCLEAR REACTORS AND POWER PLANTS. III. DATA PROCESSING ON EL 4 POWER PLANTS. Jacquin, J.-C.; Gheeraert, P.; Fontaine, A.; Leveque, R. Energ. Nucl. (Paris), 10: 506-15(Dec. 1968). (In French).

The role of the measurements in the direct control of the EL 4, based on the use of a digital computer for the information of the operator and for the development of a part of an automatic system is described. The layout of the measurement chains and some aspects of their construction are also reported. (tr-auth)

28377 THE NUCLEAR POWER STATION AT VAERTAN. (MAYBE THE FIRST NUCLEAR POWER PLANT WITHIN A CITY). Larsson, Alf (Aktiebolaget Atomenergi, Stockholm). Tek. Tidskr., 99: 207-9(1969). (In Swedish).

Discussed are the siting and design of a nuclear reactor for electric power supply and district heating within the city of Stockholm. The safety aspects are reviewed. (Sweden)

28378 PROCEEDINGS OF THE AMERICAN POWER CONFERENCE, ILLINOIS INSTITUTE OF TECHNOLOGY, CHICAGO, ILLINOIS, APRIL 23–25, 1968. VOLUME 30. Chicago, American Power Conference, 1969. 1327p. $15.00. (CONF-680418).

One hundred forty-five papers were presented at the conference. A separate abstract was prepared for each of thirty-two papers. The remaining papers discussed various aspects of electric power generation, transmission, and utilization not within scope of NSA. (R.C.K.)

For abstracts of individual papers see: 26346, 26474, 28379–28403, 28425–28428, and 28489.

28379 QUALITY ASSURANCE: AN ESSENTIAL FOR SAFE AND ECONOMIC NUCLEAR POWER. Ramey, James T. (Atomic Energy Commission, Washington, D. C.). Proc. Amer. Power Conf., 30: 21-30(1969).

From 30th Annual American Power Conference, Chicago, Ill. See CONF-680418.

The role of quality assurance in safe and economic operation of large power reactors is discussed. Problems with design and construction are outlined; efforts required on the part of utilities are listed and described. The need for nuclear standards is discussed; progress toward acceptable quality control procedures and standards is outlined. (M.L.S.)

28380 THE FUTURE ROLE OF FOSSIL FUELS IN ELECTRIC POWER GENERATION. Moore, J. Cordell (Dept. of the Interior, Washington, D. C.). Proc. Amer. Power Conf., 30: 38-43(1969).

From 30th Annual American Power Conference, Chicago, Ill. See CONF-680418.

The impact of nuclear generation of electricity is assessed with respect to coal-fired plants. Air pollution regulations and antipollution requirements for coal- and residual oil-fired plants are listed; effects on the economics of electricity production from this type of plant are described. Sulfur content of residual oil and coal used in fossil-fired plants is discussed. Methods for decreasing SO_2 effluents from power plants are considered. (M.L.S.)

28381 RELIABILITY, RESOURCES, AND ENVIRONMENT. Black, David S. (Under Secretary of the Interior, Washington, D. C.). Proc. Amer. Power Conf., 30: 72-6(1969).

From 30th Annual American Power Conference, Chicago, Ill. See CONF-680418.

The responsibilities of the utilities to preserve the natural environment as well as provide electricity are described. Joint planning among utilities for the use of large power plants and transmission lines is discussed. Uses of by-product heat from power reactors are listed and discussed briefly. (M.L.S.)

28382 THERMAL POLLUTION AND THE POWER INDUSTRY. Cadwallader, L. W. (Potomac Electric Power Co., Washington, D. C.). Proc. Amer. Power Conf., 30: 113-17(1969).

From 30th Annual American Power Conference, Chicago, Ill. See CONF-680418.

The general program of the Potomac Electric Power Company over the last decade for assessing the effects of liquid thermal discharges from fossil-fueled plants is outlined; this is proposed as a method for handling similar, but hotter, discharges from nuclear plants. (M.L.S.)

28383 UTILITY EXECUTIVES COOL ON POURING BILLIONS INTO FAST REACTOR RESEARCH. Proc. Amer. Power Conf., 30: 188-90(1969).

From 30th Annual American Power Conference, Chicago, Ill. See CONF-680418.

Concepts of priorities are contrasted for fast reactor research and development between utility executive and AEC personnel. Plutonium recycle, power reactor construction and operation, and breeder development are explored. Methods of financing and capital commitments are considered. (M.L.S.)

28384 ECONOMIC CONSIDERATIONS OF NUCLEAR FUEL WARRANTIES. Raber, Marvin; Baer, Robert (Hittman Associates, Inc., Columbia, Md.). Proc. Amer. Power Conf., 30: 228-36(1969).

From 30th Annual American Power Conference, Chicago, Ill. See CONF-680418.

The various fuel purchase options being used by utilities for fuel element supply are listed; warranty provisions are described. The dependence of fuel cycle cost on burnup is discussed; data are shown graphically. Experimental and analytical techniques for determining burnup are described. Economic effects of a standard burnup warranty are shown for an 800 MWe PWR. Effects of loss of warranty coverage are considered. (M.L.S.)

28385 INCENTIVES FOR A MIXED ECONOMY OF THERMAL AND FAST POWER REACTORS. Murphy, P. M. (General Electric Co., Sunnyvale, Calif.). Proc. Amer. Power Conf., 30: 237-45(1969).

From 30th Annual American Power Conference, Chicago, Ill. See CONF-680418.

An electrical generating system using, initially, gas turbines and other peaking plants with base-loaded fossil fuel plants is considered; effects of addition of light water reactors in the 1970's are then evaluated. Fossil-nuclear capital cost differential is shown as a function of percent installed capacity. Power generation cost characteristics are tabulated. Optimum composition of a system employing peaking plants, fossil plants, and fast and light water reactors is shown graphically. The importance of timing of fast reactor introduction is evaluated; cost incentives of fast reactor use are evaluated. (M.L.S.)

28386 ECONOMIC EFFECTS OF NUCLEAR FUEL MANAGEMENT. Hang, D. F. (Univ. of Illinois, Urbana); Koncel, E. F. Proc. Amer. Power Conf., 30: 246-54(1969).

From 30th Annual American Power Conference, Chicago, Ill. See CONF-680418.

A comparison of nuclear fuels and coal is given; economic effects on plant operations are assessed. Economic parametric studies for nuclear fueled plants are described; required factors for input for the studies are detailed. Operating times to achieve design capacity factors are tabulated. Fuel fabrication investment is shown as a function of prepayment time and time between refuelings. Recycling uranium is discussed briefly. (M.L.S.)

28387 NUCLEAR FUELS FOR POWER REACTORS. Sofer, G. A. (United Nuclear Corp., Elmsford, N. Y.); Soodak, H. Proc. Amer. Power Conf., 30: 255-65(1969).

From 30th Annual American Power Conference, Chicago, Ill. See CONF-680418.

Fuel requirements for nuclear power plants over the full life span of the plant are discussed. Information required from utilities for a reload fuel bid is tabulated; each item is described. The various tests that the fuel element manufacturer perform are discussed; tests include critical heat flux, pressure drop, environment mockup, void substitution, and minimum critical mass. The varied uses of the Pawling Lattice Test Rig (PLATR) for fuel element check out are described. Plutonium recycle in water reactors is discussed. (M.L.S.)

28388 COMPUTER PROGRAMS FOR POWER REACTOR MANAGEMENT (NUCLEAR AND THERMAL-HYDRAULIC). Gailar, Owen H. (Purdue Univ., Lafayette, Ind.); Kim, Hichull; McGeachy, J. D.; Veras, A. F. Proc. Amer. Power Conf., 30: 266-75(1969).

From 30th Annual American Power Conference, Chicago, Ill. See CONF-680418.

The use of computer programs for determining power reactor nuclear and thermal-hydraulic characteristics is discussed; requirements are outlined for these computer programs. Computer programs which are used for power reactor are categorized and tabulated; categories include: neutron cross-section calculations: monoenergetic, one-dimensional transport theory; few-group diffusion theory spatial flux distributions; depletion programs—few-group diffusion theory; and combined programs. The type of computer on which the program is indicated, also. (25 references) (M.L.S.)

28389 NUCLEAR FUEL MANAGEMENT FOR UTILITIES. Fulford, P. J. (Purdue Univ., Lafayette, Ind.); Casey, Suzanne R.; Swanson, Richard. Proc. Amer. Power Conf., 30: 276-81 (1969).

From 30th Annual American Power Conference, Chicago, Ill. See CONF-680418.

Nuclear fuel management and the ability of the utilities to handle the necessary tasks in-house are discussed. Management practices used by Commonwealth Edison are discussed; the Purdue nuclear fuel management is outlined. (M.L.S.)

28390 NUCLEAR POWER AT OCONEE. Lee, W. S. (Duke Power Co., Charlotte, N. C.); Rowland, W. H. Proc. Amer. Power Conf., 30: 282-94(1969).

From 30th Annual American Power Conference, Chicago, Ill. See CONF-680418.

The three unit Oconee Nuclear Station is discussed; the station site is described. The general station arrangement is discussed; a simplified station diagram is shown. The station electrical system is described. Details of plant design include: nuclear steam system, cooling systems, engineered safeguards, and instrumentation and control. (M.L.S.)

28391 ROCHESTER GAS AND ELECTRIC POWER SYSTEM AND SITE CONSIDERATIONS. Koprowski, R. R. (Rochester Gas and Electric Corp., N. Y.). Proc. Amer. Power Conf., 30: 295-8(1969).

From 30th Annual American Power Conference, Chicago, Ill. See CONF-680418.

The service area of the Rochester Gas and Electric Company is defined. Load growth is discussed. The economics of using nuclear fuel plants in the company's expansion are considered. Details of the Robert E. Ginna, Unit 1 site are given. (M.L.S.)

28392 PLANT DESCRIPTION. Powell, E. U.; Harper, R. M. (Westinghouse Electric Corp., Pittsburgh). Proc. Amer. Power Conf., 30: 298-311(1969).

From 30th Annual American Power Conference, Chicago, Ill. See CONF-680418.

A description of the Robert E. Ginna Power Reactor, Unit 1 is given. A site-plot plan shows the general arrangement of the plant; the screen house is described. A description is included of: the core, cooling system, engineered safeguards, containment, instrumentation and controls, turbine and generator, condensers, feedwater cycle, and electrical systems. (M.L.S.)

28393 CONTAINMENT VESSEL. Croneberger, D. K. (Gilbert Associates, Inc., Reading, Pa.). Proc. Amer. Power Conf., 30: 312-20(1969).

From 30th Annual American Power Conference, Chicago, Ill. See CONF-680418.

A general description and design concepts of the Robert E. Ginna Power Reactor, Unit 1 are given; a cross section of the containment vessel is included. Details of electrical penetrations are shown. Descriptions are included of: the liner and penetrations, rock anchors, hinge, vertical tendons, concrete reinforcement, large openings, and liner insulation. (M.L.S.)

28394 DESIGN AND OPERATING FEATURES OF LARGE PWR SYSTEMS. Abbott, W. E.; Bevilacqua, F.; Hanzalek, F. J. (Combustion Engineering, Inc., Windsor, Conn.). Proc. Amer. Power Conf., 30: 321-35(1969).

From 30th Annual American Power Conference, Chicago, Ill. See CONF-680418.

Core mechanical design for large pressurized water power reactors is discussed. Design parameters are tabulated for an 800 MWe pressurized water reactor. The instrumentation and protection system design and plant control are discussed. Reactor vessel and steam generator design parameters are tabulated for 500 MWe, 800 MWe, and 1100 MWe systems. (M.L.S.)

28395 NUCLEAR POWER PLANT OPERATOR TRAINING AND QUALIFICATION. Guppy, W. H. (Commonwealth Edison Co., Chicago); Masche, G. C. Proc. Amer. Power Conf., 30: 336-46(1969).

From 30th Annual American Power Conference, Chicago, Ill. See CONF-680418.

Methods and costs of training nuclear power plant operators are discussed. Planning for and operation of simulators, especially the BWR simulator at the Dresden site, are described. Responsibility and experience are considered. The basic features of an effective training program are considered. Programmed simulator malfunctions are tabulated. In-plant training is considered briefly. (M.L.S.)

28396 ICE CONDENSER REACTOR CONTAINMENT SYSTEM. Dragoumis, Paul (American Electric Power Service Corp., New York); Weems, Sterling J.; Lyman, Walter G. Proc. Amer. Power Conf., 30: 347-55(1969).

From 30th Annual American Power Conference, Chicago, Ill. See CONF-680418.

A description of the concept of an ice condenser containment system is given. The full scale test facility used to test the ice condenser system is described. Pressure transients and containment response are discussed. Cutaways show views of the upper and lower compartments. Use in the Donald C. Cook Power Reactors, Units 1 and 2, is discussed. (M.L.S.)

28397 FORT ST. VRAIN PRESTRESSED CONCRETE REACTOR VESSEL. Walker, R. F. (Public Service Co. of Colorado, Denver); Northup, T. E. Proc. Amer. Power Conf., 30: 356-63(1969).

From 30th Annual American Power Conference, Chicago, Ill. See CONF-680418.

The general features for the prestressed concrete reactor vessel (PCRV) for the Fort St. Vrain Power Reactor, Unit 1 are discussed. Load conditions and design criteria are listed; limit design and conditions are given. Cutaways show the reactor primary system and major PCRV components. PCRV pressures are tabulated. Reactor vessel construction is discussed briefly. (M.L.S.)

28398 SHOREHAM NUCLEAR POWER STATION WITH CONCRETE CONTAINMENT. Burns, W. J. (Long Island Lighting Co., Hicksville, N. Y.); Kennedy, W. J. L.; Weinzimmer, Fred. Proc. Amer. Power Conf., 30: 364-70(1969).

From 30th Annual American Power Conference, Chicago, Ill. See CONF-680418.

The concept of composite containment used in the design for the Shoreham Power Reactor, Unit 1 is described. The advantages of composite containment are discussed; these are: improved safety characteristics, flexibility in construction, cost savings, and better use of construction labor. Principal design parameters are tabulated; cutaways show the five-stage containment building and the refueling and service floors. A general description of proposed construction and practices is given. (M.L.S.)

28399 THE MONTICELLO STATION WITH FIELD CONSTRUCTION OF THE REACTOR VESSEL. Jensen, R. J. (Northern States Power Co., Minneapolis); Parkinson, G. L.; Webb, R. S.; Violette, J. B. Proc. Amer. Power Conf., 30: 371-82(1969).

From 30th Annual American Power Conference, Chicago, Ill. See CONF-680418.

Electrical generation requirements for the Northern States Power Company are discussed. Feasibility studies of shipping a shop assembled vessel to the Monticello Power Reactor site are discussed. Vessel fabrication and assembly at the Monticello site are detailed; field machining and welding are described. Quality assurance and construction interfaces with vessel fabrication are discussed. (M.L.S.)

28400 FEED PUMP TURBINES FOR NUCLEAR PLANTS. Pierpoline, M. F.; Munnis, J. A. (Westinghouse Electric Corp., Pittsburgh). Proc. Amer. Power Conf., 30: 450-7(1969).

From 30th Annual American Power Conference, Chicago, Ill. See CONF-680418.

Technical and economic advantages of using turbine drives for boiler feed pumps are described. Feed pump requirements are shown as a function of main unit rating. Pump and turbine drive characteristics are tabulated. Operation of nuclear fuel cycles with feed pump turbines is discussed; power reactors using feed pump turbines are listed. Turbine control and design philosophy are discussed. (M.L.S.)

28401 THE DESIGN AND OPERATING EXPERIENCE OF CONNECTICUT YANKEE ATOMIC POWER COMPANY'S HADDAM NECK NUCLEAR PLANT. Vandenburgh, D. E. (Yankee Atomic Electric Co., Boston); Chave, C. T.; Martin, J. A. Jr. Proc. Amer. Power Conf., 30: 521-35(1969).

From 30th Annual American Power Conference, Chicago, Ill. See CONF-680418.

A general background on the Connecticut Yankee Power Reactor is given. Total capital requirements for the plant are outlined. The containment system, steam generator supports, boron recovery system, waste gas handling system, and methods for heating the various outdoor storage tanks are discussed. The steam and power conversion system is described in some detail; included are descriptions of: steam inlet features, high pressure turbine, cross under piping, moisture separator-reheaters, low pressure turbines, main condensers, condensate system, generator-exciter, and overspeed operation of the turbine-generator unit. (M.L.S.)

28402 HEAT RATE PERFORMANCE OF NUCLEAR STEAM TURBINE-GENERATORS. Spencer, R. C.; Booth, J. A. (General Electric Co., Schenectady, N. Y.). Proc. Amer. Power Conf., 30: 536-44(1969).

From 30th Annual American Power Conference, Chicago, Ill. See CONF-680418.

Effects on heat rate of variations in cycle and turbine-generator parameters for units operating with standard or low superheat initial conditions are discussed. Expansion lines are shown for reheat and nonreheat cycles. Effects of increase of initial pressure, moisture, and superheat are shown graphically; each effect is discussed. Part-load performance of the turbine-generator is analyzed. (M.L.S.)

28403 NUCLEAR SITING SURVEY OF THE PACIFIC NORTHWEST AND ITS IMPACT ON TRANSMISSION PLANNING. Burnham, J. B. (Battelle-Northwest, Richland, Wash.); Fletcher, J. F.; Tallman, R. J.; Warchol, E. J. Proc. Amer. Power Conf., 30: 1169-80(1969).

From 30th Annual American Power Conference, Chicago, Ill. See CONF-680418.

Preferred nuclear power plant siting areas in the Pacific Northwest are described. Site criteria are discussed; these include: transmission, hydrology, biology, geology, meteorology, and population density is considered. Capital cost considerations and site cost estimates are discussed. Power generation costs are tabulated as a function of major variable. (11 references) (M.L.S.)

28404 CONCEPTUAL DESIGN OF AN INTEGRAL PRIMARY CIRCUIT FOR THE EDF-4 REACTOR. Gaussot, D.; Brignon, P. (Electricite de France, Paris). pp EN.1/8.1-10 of Symposium on the Technology of Integrated Primary Circuits for Power Reactors, Proceedings, Paris, 20th–22nd May 1968. Paris, European Nuclear Energy Agency, 1968. (In French).
See CONF-680525.

The advantages and problems of an integrated primary circuit are described. Design of the integrated primary circuit for the EDF-4 (Saint-Laurent-des-Eaux) Reactor is detailed; schematics are shown. (M.L.S.)

28405 COMMISSIONING AND OPERATION OF THE REACTOR PRIMARY CIRCUIT AT OLDBURY POWER STATION. Horne, A.; Westerman, M. (Central Electricity Generating Board, London). pp EN.1/30.1-15 of Symposium on the Technology of Integrated Primary Circuits for Power Reactors, Proceedings, Paris, 20th–22nd May 1968. Paris, European Nuclear Energy Agency, 1968.
See CONF-680525.

Design parameters for the Oldbury Reactors are described. Commissioning and startup operation sequences are presented. Startup performance is analyzed. (D.C.C.)

28406 SUBMERGED CIRCULATOR UNIT FOR GAS COOLED REACTORS. Fraser, W. M. (James Howden and Co. Ltd., Glasgow). pp EN.1/36.1-16 of Symposium on the Technology of Integrated Primary Circuits for Power Reactors, Proceedings, Paris, 20th–22nd May 1968. Paris, European Nuclear Energy Agency, 1968.
See CONF-680525.

Design characteristics and requirements for gas-cooled reactors with submerged blowers are described. A review of the Hinkley Point 2 Reactors cooling system is presented. (2 references) (D.C.C.)

28407 DESIGN AND CONSTRUCTION OF THE REACTOR PRIMARY CIRCUIT AT OLDBURY POWER STATION. Southwood, J. R. M. (Nuclear Power Group Ltd., Knutsford, Eng.). pp EN.1/29.1-15 of Symposium on the Technology of Integrated Primary Circuits for Power Reactors, Proceedings, Paris, 20th–22nd May 1968. Paris, European Nuclear Energy Agency, 1968.
See CONF-680525.

Design parameters for the Oldbury Reactors cooling systems are described. (D.C.C.)

28408 CONTROL-ROD DRIVES FOR PHWR, BHWR, AND BWR REACTORS. Gavlefors, S.; Joensson, E. (Allmanna Svenska Electriska A. B., Vasteras, Sweden). pp EN.1/26.1-15 of Symposium on the Technology of Integrated Primary Circuits for Power Reactors, Proceedings, Paris, 20th–22nd May 1968. Paris, European Nuclear Energy Agency, 1968.
See CONF-680525.

Control rod drive mechanisms for the Swedish Reactors (R-3), Swedish Reactors (R-4), and Oskarshamn Power Reactor are described. (D.C.C.)

28409 INTERNAL REFUELLING MACHINE FOR BHWR REACTORS. Gavlefors, S.; Mansson, R. (Allmanna Svenska Electriska A. B., Vasteras, Sweden). pp EN.1/25.1-14 of Symposium on the Technology of Integrated Primary Circuits for Power Reactors, Proceedings, Paris, 20th–22nd May 1968. Paris, European Nuclear Energy Agency, 1968.
See CONF-680525.

General information concerning the internal on-load fuel handling equipment for the Swedish Reactor (R-4) is presented. (D.C.C.)

28410 CONCEPTUAL DESIGN OF THE COMPONENTS OF THE PRIMARY CIRCUIT OF THE EDF-4 REACTOR. Gaussot, D.; Brignon, P. (Electricite de France, Paris). pp EN.1/3.1-13 of Symposium on the Technology of Integrated Primary Circuits for Power Reactors, Proceedings, Paris, 20th–22nd May 1968. Paris, European Nuclear Energy Agency, 1968. (In French).
See CONF-680525.

The design of the core and intervals for the EDF-4 (Saint-Laurent-des-Eaux) Reactor is described. Primary heat exchanger and pressure vessel designs are discussed. The coolant circulators are described. (M.L.S.)

28411 PRIMARY CIRCUITS FOR GAS-COOLED REACTORS. Warner, P. C.; Bennett, J. C. (Atomic Power Constructions Ltd., Sutton, Eng.). pp EN.1/31.1-15 of Symposium on the Technology of Integrated Primary Circuits for Power Reactors, Proceedings, Paris, 20th–22nd May 1968. Paris, European Nuclear Energy Agency, 1968.
See CONF-680525.

Basic principles which regulate the engineering of primary circuits for gas-cooled reactors are analyzed. A description of the Dungeness B Reactors primary circuit is included. (5 references) (D.C.C.)

28412 BRITISH NUCLEAR POWER DEVELOPMENT. Eltham, B. E. pp 1-7 of British Nuclear Power Plant. [Proceedings of the] Bangkok Symposium, November 1968. London, British Nuclear Export Executive. Bangkok, Office of Atomic Energy for Peace, 1968.
See CONF-681125.

The development and performance of gas-cooled, steam-generated heavy water, and fast reactors are reviewed in relation to the UK nuclear power programme. (UK)

Power Reactor Development

Refer also to abstract 28593.

28413 (GA-8476) FREVAP-8 COMPUTER CODE FOR CALCULATING THE RELEASE OF METALLIC FISSION PRODUCTS. Zumwalt, L. R.; Pierce, V. H.; Welch, J. E.; Norman, J. H. (Gulf General Atomic, Inc., San Diego, Calif.). June 15, 1968. Contract AT(04-3)-633. 182p. Dep. CFSTI.

The analytical formulation of the FREVAP computational method is presented. The FREVAP-8 computer program developed from the FREVAP formulation and written for the UNIVAC 1108 computer is listed. A sample problem typical of calculations made using the code to estimate core release of the condensable fission product species for high-temperature gas-cooled reactors is described. Detailed FORTRAN listings and flow diagrams of the main program and significant subroutines are included. The list of program variable labels and variable names used in the FREVAP formulation is tabulated for cross reference. The sample problem represents a typical HTGR calculation. A description of the problem discusses the practical application of the code to accommodate the geometric properties and the time, temperature and power related properties of a typical reactor. A listing of the sample problem input data and code output are included for reference. (auth)

28414 (JUL-556-PA-RG) ECONOMIC POTENTIAL OF DIFFERENT ADVANCED REACTOR CONCEPTS IN A FUTURE POWER GENERATING SYSTEM. Boettcher, A.; Kraemer, H.; Wagemann, K. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorentwicklung). Oct. 1968. 24p. (CONF-681101-29). Dep.

From International Conference on the Constructive Uses of Atomic Energy, Washington, D. C.

Optimum economic power reactor systems development programs for the U. S. and Germany are presented. Calculations for various reactor types are presented for optimum economic development during 1970 to 2020. 5 references. (D.C.C.)

28415 (ORNL-4389) GAS TRANSPORT IN MSRE MODERATOR GRAPHITE. II. EFFECTS OF IMPREGNATION. III. VARIATION OF FLOW PROPERTIES. Evans III, R. B.; Rutherford, J. L.; Malinauskas, A. P. (Oak Ridge National Lab., Tenn.). May 1969. Contract W-7405-eng-26. 56p. Dep. CFSTI.

A detailed investigation of the gas transport characteristics of MSRE moderator graphite has been conducted. These studies demonstrate that the impregnation treatments which had been applied for purposes of permeability reduction yield a material which is nonhomogeneous with respect to gas transport. For the specimen on which the most extensive measurements had been made, the inhomogeneity imparted to the sample as a result of impregnation was such that the characteristic transport coefficients were found to increase approximately exponentially from the surface to the core of the graphite. All of the moderator graphite which was surveyed was sufficiently impermeable that gas transport at conditions of reactor operation could be approximated reasonably well by considering only the free-molecule or Knudsen mechanism, although the overall variation of the Knudsen transport coefficient was observed to be of the order of 10^3. A simple mathematical model was developed to predict the transport characteristics of fission product gases in the MSRE graphite. Comparison with in-pile experimental data yielded amazingly good agreement for the short-lived isotopes. On the basis of this comparison, it appears feasible to eliminate expensive sectioning and counting techniques employed to determine concentration profiles of the fission products in the MSRE moderator graphite in favor of gas transport measurements for those species which have noble-gas precursors. However, in-pile experiments have special merit in other respects; for example, they yield information about nuclides that do not have gaseous precursors. (auth)

28416 (RISO-M-864) HEBUS: A 3-DIMENSIONAL HETEROGENEOUS BURNUP AND SHUFFLING PROGRAMME. Pedersen, J. (Danish Atomic Energy Commission, Risoe. Research Establishment). Mar. 1969. 34p. Dep.

The computer program HEBUS is described. The program is a combination of the point burnup program PBU, the 3-dimensional heterogeneous program SOUSI 3DR, and procedures for loading, unloading and shuffling of fuel elements. 8 references. (auth)

28417 (TRG-Report-1801(Rev.)) PLACE OF THE FAST REACTOR IN COMMERCIAL POWER DEVELOPMENT. Marsham, T. N. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). 1969. 13p. (CONF-680625-2). Dep. CFSTI. UK 2s. 0d.

From BNX/BNF Nuclear Power Meeting, Copenhagen, Denmark.

The importance of fast reactors in the UK reactor development program is discussed, and the economic objectives of the early commercial fast reactors are outlined. Progress in development leading to the present status of the PFR is described. Future prospects are considered. 11 references. (UK)

28418 IMPROVEMENTS IN MODERATOR CORE STRUCTURES FOR NUCLEAR REACTORS. Triggs, Geoffrey William; Prince, Norman (to United Kingdom Atomic Energy Authority). British Patent 1,150,730. Apr. 30, 1969. Filed July 21, 1966.

The core structure for a gas-cooled graphite-moderated reactor is described. The core consists of prismatic graphite blocks arranged end to end in columns which define fuel element channels. It has been usual to key the blocks together with keys fitting in keyways oriented so as to lie in planes radial relative to the axes of the blocks. With this arrangement serious stressing can occur in the keys due to bowing of the blocks under irradiation. In the arrangement described the keying members are limited in length to less than half the length of the blocks which they key, and are supported within the length of the blocks by loose fitting spacing members. The axes of the blocks may be vertical and the keying members located in the upper half of the blocks, without reaching the upper ends of the blocks. (UK)

28419 PLANNING A 1100 MW NUCLEAR POWER STATION WITH A BOILING WATER REACTOR. Borgstedt, Karl-Eberhard; Taurit, Rudolf (Allgemeine Elektricitaets-Gesellschaft, Frankfurt am Main). At. Strom, 15: 22-31(Feb.-Mar. 1969). (In German).

The planning of an 1100 MW nuclear power station with a boiling water reactor has been brought to the stage where construction can begin. In the arrangement special attention is paid to the problems encountered in the transition from the largest unit which is so far under construction (640 MW net) to the output of 1100 MW. Careful weighing of the technical risks, in particular for the manufacture of individual components, led to an arrangement which, in accordance with the relevant criteria, does not appear to involve greater risks in operation than with the installations of the present size. Design and operation characteristics are tabulated. Cut-aways show the conceptual architectural layouts. (auth)

28420 IMPROVEMENTS IN NUCLEAR REACTORS. Peters, Martin Charles (to Babcock and Wilcox Ltd.). British Patent 1,151,565. May 7, 1969. Filed Dec. 9, 1965.

A gas-cooled nuclear reactor with a concrete pressure vessel and internal heat exchangers is described. The dividing wall which separates the space receiving fuel element channel coolant from the space containing moderator coolant is substantially flat, instead of the more usual edge-supported convex-concave plate form. The fuel element loading guide tubes are arranged to act as struts between the division wall and the concrete pressure vessel, to assist this wall in withstanding the differential coolant gas pressure. (UK)

28421 DEVELOPMENT PROJECT OF NEW TYPE CONVERTER AND FAST BREEDER REACTORS. Fujiwara, Satoru. Ohm (Elec. Mag.), 55: No. 14, 56-64(Dec. 1968). (In Japanese).

The Fast Breeder Reactor to be developed employs mixed oxides of Pu and U, cooled with Na; the Advanced Thermal Reactor, on the other hand, is a heavy water-moderated, boiling light water-cooled reactor. The national program for the development of the ATR and FBR, and the development studies so far performed are described. (NSA of Japan)

28422 HETEROGENEOUS NUCLEAR REACTOR. (to Siemens-Schuckertwerke Aktiengesellschaft). British Patent 1,150,156. Apr. 30, 1969. Priority date Aug. 26, 1965, Germany.

REACTORS, HETEROGENEOUS—core configuration for power superheating, description of opposing-flow dual-region
REACTORS, POWER—core configuration for heterogeneous superheating, description of opposing-flow dual-region
REACTORS, SUPERHEATING—core configuration for power heterogeneous, description of opposing-flow dual-region
(D.C.C.)

28423 REACTOR AND FUEL-PROCESSING TECHNOLOGY. Volume 12, Number 1. One of the Four Technical Progress Reviews Published for the Division of Technical Information, USAEC. Washington, D. C., Atomic Energy Commission, Fall 1968-1969. 116p. GPO $0.70.

Separate abstracts are included for each of the 10 papers presented. Topics discussed include: test reactor perspectives; Xe transient calculations in large water-moderated reactors; tritium in power reactors; large-scale fuel reprocessing plants; technical specifications for first-generation power plants; reliability techniques for operating systems and design optimization; radiolytic decomposition of water in water-moderated reactors under accident conditions; brine heater leakage-control problems in large nuclear power and desalting plants; thermal bowing in pin-type fuel elements; and economic optimum power densities for water-moderated reactor fuels. (D.C.C.)

For abstracts of individual papers see: 26339, 28443, 28491, 28497, 28526-28528, 28566, 28595, and 28638.

28424 VISTAS IN ELECTRIC POWER. VOLUMES 1, 2, AND 3. Sporn, Philip. New York, Pergamon Publishing Company, 1968. 1123p. $45.00.

A selection of the written and spoken works of Dr. Philip Sporn in the field of electric power supply is presented. Technical and economics aspects of nuclear power generation, the position of nuclear energy in the U. S. power supply future, and the effects of nuclear power on fossil fuel requirements are discussed. The bulk of the works concern generation, transmission, and management aspects of conventional electric power supply systems. (H.D.R.)

28425 IMPORTANCE OF BREEDER PROGRAM: INTRODUCTORY REMARKS. Tape, Gerald F. (Atomic Energy Commission, Washington, D. C.). Proc. Amer. Power Conf., 30: 161-7(1969).

From 30th Annual American Power Conference, Chicago, Ill. See CONF-680418.

Reasons for breeder reactor development are outlined. The molten salt breeder concept and fast breeder systems are described. The role of the AEC in promoting breeder reactor development is discussed briefly. (M.L.S.)

28426 UTILITY PARTICIPATION IN THE AEC FAST BREEDER REACTOR PROGRAM. Ramey, James T. (Atomic Energy Commission, Washington, D. C.). Proc. Amer. Power Conf., 30: 168-73(1969).

From 30th Annual American Power Conference, Chicago, Ill. See CONF-680418.

Needs and ways for utility participation in the development of fast breeder reactors are described. Joint government-industry participation, both technically and financially, in LMFBR development and in demonstration plants is discussed. Participation in safety programs and nuclear training programs is outlined. Specific recommendations are listed. (M.L.S.)

28427 THE UNITED STATES FAST BREEDER REACTOR PROGRAM. Shaw, Milton (Atomic Energy Commission, Washington, D. C.). Proc. Amer. Power Conf., 30: 173-88(1969).

From 30th Annual American Power Conference, Chicago, Ill. See CONF-680418.

The orders and additions to installed nuclear capacity are tabulated. Estimated nuclear generating capacity in the U. S. through the year 2000 is shown graphically. Effects of fast breeder introduction on the uranium commitments are shown. Advantages and disadvantages are tabulated for sodium, steam, and helium coolants for fast breeder reactors. The LMFBR program plan is described. Light water reactor and fast breeder reactor development time schedules are shown through 1970. The significant accomplishments in the LMFBR development program are tabulated through April 1968. (M.L.S.)

28428 THE GENERAL PUBLIC UTILITIES/ATOMICS INTERNATIONAL FAST BREEDER REACTOR DEMONSTRATION PLANT. Dieckamp, H. (Atomics International, Canoga Park, Calif.); Roddis, L. H. Jr. Proc. Amer. Power Conf., 30: 191-210(1969).

From 30th Annual American Power Conference, Chicago, Ill. See CONF-680418.

General Public Utilities' (GPU) experience with both nuclear and fossil-fueled electrical generating stations is summarized. The joint GPU-Atomics International (AI) fast breeder demonstration plant is discussed; design and performance characteristics are tabulated. A description of the reactor, nuclear, and plant systems is given. Safety aspects of the reactor are listed.

Plant control, station staffing, operation and maintenance, fuel handling, vessel inspection, and fuel cycle costs are discussed briefly. (M.L.S.)

28429 COMPARISON BETWEEN INTEGRATED AND PRESSURE TUBE DESIGN FOR A GAS COOLED, HEAVY WATER MODERATED REACTOR. Burgsmueller, P.; Helbling, W.; Naegelin, R. (Therm-Atom Ltd., Zurich). pp EN.1/28.1-18 of Symposium on the Technology of Integrated Primary Circuits for Power Reactors, Proceedings, Paris, 20th–22nd May 1968. Paris, European Nuclear Energy Agency, 1968.
See CONF-680525.

Characteristics of gas-cooled heavy water-moderated pressure tube and integrated reactors are compared. Comparisons include: design parameters; safety; specialized components; accessibility and maintenance; and economics. (D.C.C.)

28430 SOME DESIGN ASPECTS OF BHWRS. Menon, S. K.; Haga, I.; Froeman, G. (Aktiebolaget Atomenergi, Stockholm). pp EN.1/22.1-14 of Symposium on the Technology of Integrated Primary Circuits for Power Reactors, Proceedings, Paris, 20th–22nd May 1968. Paris, European Nuclear Energy Agency, 1968.
See CONF-680525.

Design characteristics of conceptual 600 MW(e) indirect cycle integrated boiling heavy water reactors are presented. The reactor type discussed is fueled with natural uranium and is contained in a prestressed concrete pressure vessel. The operational requirements for a fully integrated refueling machine are described. The burnup losses and cost of shutdown with off-load refueling are compared to on-load refueling. 7 references. (D.C.C.)

28431 PRIMARY CIRCUIT OF AN ADVANCED GAS COOLED REACTOR. Acciari, P. (Snam Progetti, Milan); Southwood, J. R. M. pp EN.1/20.1-13 of Symposium on the Technology of Integrated Primary Circuits for Power Reactors, Proceedings, Paris, 20th–22nd May 1968. Paris, European Nuclear Energy Agency, 1968.
See CONF-680525.

Design parameters for the proposed Italian 620 MW(e) advanced gas-cooled graphite-moderated reactor are presented. (D.C.C.)

28432 DESIGN STUDIES FOR 1000 MWe GAS-COOLED FAST BREEDER REACTORS. Fortescue, P.; Melese-d'Hospital, G.; Meyer, L. (Gulf General Atomic Europe, Zurich). pp EN.1/46.1-16 of Symposium on the Technology of Integrated Primary Circuits for Power Reactors, Proceedings, Paris, 20th–22nd May 1968. Paris, European Nuclear Energy Agency, 1968.
See CONF-680525.

General design parameters for conceptual 1000 MW(e) gas-cooled fast breeder power reactors are presented. Future development programs are described. 11 references. (D.C.C.)

28433 SOME CONSIDERATIONS FOR THE ERECTION OF THE PRIMARY CIRCUIT OF AN AGR. Marnet, Ch.; Schneck, M. (Brown, Boveri and Cie AG, Mannheim, Ger.). pp EN.1/9.1-12 of Symposium on the Technology of Integrated Primary Circuits for Power Reactors, Proceedings, Paris, 20th–22nd May 1968. Paris, European Nuclear Energy Agency, 1968.
See CONF-680525.

The fabrication and construction requirements for core components and the prestressed concrete pressure vessels for advanced gas-cooled reactors are described. (D.C.C.)

28434 SYMPOSIUM ON THE TECHNOLOGY OF INTEGRATED PRIMARY CIRCUITS FOR POWER REACTORS, PROCEEDINGS, PARIS, 20TH–22ND MAY 1968. Paris, European Nuclear Energy Agency, 1968. 650p. (In English and French). (CONF-680525).

Separate abstracts are included for each of the 44 papers presented. Topics discussed include: integrated direct cycle gas turbine circuits; components for integrated primary circuits; and safety aspects of integrated primary circuits. (D.C.C.)

For abstracts of individual papers see: 28404–28411, 28429–28433, 28435, 28455, 28468–28482, 28498, 28529, 28531–28534, 28539–28545, and 28640.

28435 HIGH TEMPERATURE GAS-COOLED REACTORS WITH GAS TURBINE. Bammert, K.; Boehm, E. (Technical Univ., Hanover. Gutehoffnungshuette Sterkrade AG, Oberhausen, Ger.). pp EN.1/12.1-16 of Symposium on the Technology of Integrated Primary Circuits for Power Reactors, Proceedings, Paris, 20th–22nd May 1968. Paris, European Nuclear Energy Agency, 1968.
See CONF-680525.

General layouts are described for high-temperature helium-cooled power reactors with gas turbines. The design parameters for the proposed 25 MW(e) Geesthacht gas turbine gas-cooled reactor are discussed. (D.C.C.)

28436 GENERAL ASPECTS OF THE FAST REACTOR FAMILY. Vilain, Jacques (Joint Nuclear Research Centre, Petten, Netherlands). Euro-Spectra, 8: No. 1, 15-20(Mar. 1969).

Immediate and long-term advantages of fast reactors are examined, and development programs underway in the Euratom countries, Great Britain, U. S., and U.S.S.R. are reviewed. Technical and economic aspects of the race to provide commercial fast power reactors are discussed. (H.D.R.)

28437 BRITISH NUCLEAR POWER PLANT. [Proceedings of the] Bangkok Symposium, November 1968. London, British Nuclear Export Executive. Bangkok, Office of Atomic Energy for Peace, 1968. 62p. (CONF-681125).

Separate abstracts were prepared for the five papers presented. (UK)

For abstracts of individual papers see: 28412, 28438, 28439, 28490, and 28499.

28438 GAS COOLED-REACTOR DESIGNS. Smith, D. R. pp 8-21 of British Nuclear Power Plant. [Proceedings of the] Bangkok Symposium, November 1968. London, British Nuclear Export Executive. Bangkok, Office of Atomic Energy for Peace, 1968.
See CONF-681125.

Developments in the design of AGR and HTR power stations are discussed with reference to the Hinkley Point "B" and Dragon designs. Costs of the two designs are compared. (UK)

28439 STEAM GENERATING HEAVY WATER REACTOR. Hicks, D. pp 22-43 of British Nuclear Power Plant. [Proceedings of the] Bangkok Symposium, November 1968. London, British Nuclear Export Executive. Bangkok, Office of Atomic Energy for Peace, 1968.
See CONF-681125.

The design concept of the SGHWR is presented and certain advantages claimed. The 100 MW(e) Winfrith plant is described. The additional features envisaged for later commercial plants arising from the continuing research, development, and design program are discussed. (UK)

28440 ATOMIC POWER AT COMPETITIVE RATE: INDIA'S EFFORT. Bose, D. M. Sci. Cult. (Calcutta), 34: 261-8(July 1968).

The production of electricity at competitive rates in India is reviewed beginning with the construction of the 400 MW(e) Tarapur reactor. Brief reviews are included on the discovery of the fission process and the development of nuclear reactors in the USA, Canada, and the UK. Economics of power reactors in the USA and the UK are compared, and the future prospects for nuclear power production in India are discussed. (H.D.R.)

Kinetics and Dynamics

28441 (BAW-3867-7) PARAMETRIC EVALUATION OF THE INFLUENCE OF ^{239}Pu AND FISSION PRODUCT CAPTURE CROSS SECTIONS ON LMFBR PERFORMANCE. Stewart, J. E. (Babcock and Wilcox Co., Lynchburg, Va. Power Generation Div.). Mar. 1969. Contract AT(30-1)-3867. 69p. Dep. CFSTI.

Effects of large uncertainties on the ^{239}Pu capture cross section, over the entire spectrum, on the depletion and fuel management characteristics in an LMFBR core are evaluated. Two-zone spherical cores with volumes of 2000 and 8000 liters are considered. Results of depletion calculations, from startup to equilibrium, are given for a two-batch core refueling scheme. Cross section variation effects are tabulated for: breeding ratios, mass balances, enrichments, power peaking factors, and discharge plutonium isotopic mixes. Isotopic worths for fuel, fission products and sodium, and Doppler coefficients were compared for the equilibrium cycle. (M.L.S.)

28442 (WCAP-3696-8) PRESSURIZED WATER REACTOR pH-REACTIVITY EFFECT. Final Report. Cermak, J. O.; Columbo, R. W.; Fletcher, W. D.; (and others) (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Oct. 1968. Contract AT(30-1)-3696. 162p. (EURAEC-2074). Dep. CFSTI.
Work Performed under United States–Euratom Joint Research and Development Program.

An experimental program was performed to develop an understanding of the pH-reactivity effect observed in the operation of several closed-cycle water reactors. Reactor tests were conducted in the Yankee, Saxton, and ENEL (Trino, Italy) reactors to quantify the effect of coolant pH changes on reactivity under plant operating conditions, and to explore variables which could be identified through power level transients such as power swings and reactor trips. In-pile experiments were performed with an instrumented fuel assembly and a reactivity oscillator to provide more detailed data and better controlled test conditions than were obtainable from overall plant tests. Out-of-pile laboratory studies were performed to determine the effect of coolant chemistry under conditions which could not be effectively instrumented or controlled during in-pile operation. Analytical studies simulating in-pile conditions were made to determine the expected effects of various parameters, and to relate reactor data to both in-pile and out-of-pile experiments. Results obtained during the program are presented. (auth)

28443 XENON-TRANSIENT CALCULATIONS IN LARGE LIGHT-WATER REACTORS. Lacy, P. S.; Kendrick, E. D. (Nuclear Associates International Corp., Rockville, Md.). Reactor Fuel-Process. Technol., 12: No. 1, 10-18(Winter 1968-69).

In the design and operation of large light-water reactors, it is desirable to be able to calculate xenon transients in three dimensions with fuel and coolant thermal feedbacks and coolant hydraulic feedback. In this way the effects of control rod positioning, coolant density and temperature distribution, fuel burnup, and neutron coupling between core regions can be accurately represented. Methods used for analysis of the effects of transients in the spatial distribution of xenon are reviewed. Analyses are included for divergent and convergent spatial redistributions in power due to xenon transients. 23 references. (H.D.R.)

28444 A THREE-DIMENSIONAL ANALYSIS OF XENON-INDUCED OSCILLATIONS IN BOILING WATER COOLED REACTORS. Shinoda, Wataru; Mitake, Susumu (Japan Atomic Energy Research Inst., Tokai, Japan). Nucl. Sci. Eng., 36: 372-88(June 1969).

The Xe-induced spatial oscillations in boiling water reactors are analyzed by the use of a three-dimensional Xe dynamics code FILE-6, which solves the one-group neutron diffusion equation simultaneously with the steady state thermo-hydrodynamics equations and with the I_2-to-Xe equations in the time domain. The stability limit of the first azimuthal mode in terms of the void coefficient of reactivity is determined for a 500 MW(e) heavy water moderated boiling water reactor. It has also been shown that a positive void coefficient may have a stabilizing effect on the axial higher modes depending on the inlet subcooling, that the mode coupling between the axially zeroth and the first modes through voids has a stabilizing effect, and that when the first azimuthal mode is oscillating, higher harmonics are excited in some of higher modes through the nonlinear reactivity feedback. 13 references. (auth)

28445 ANALYTICAL AND EXPERIMENTAL INVESTIGATIONS OF THE KINETIC BEHAVIOR OF A URANIUM-DIOXIDE-FUELED PRESSURIZED-WATER REACTOR. Houghtaling, J. E.; Grund, J. E. (Phillips Petroleum Co., Idaho Falls, Idaho). Nucl. Sci. Eng., 36: 412-26(June 1969).

Reactor kinetics investigations have been performed for cold startup, hot startup, hot-standby, and operating power reactivity accidents using the UO_2 fueled, pressurized water type SPERT III reactor. Power excursion behavior was predicted for every SPERT III experiment by digital computer calculations using the SPERT-developed PARET code. Extrapolations for severe cold startup excursion consequences were obtained from several transient tests on SPERT III fuel samples in the SPERT IV capsule driver core. Analyses of the SPERT III data show that prompt moderator heating was as significant as the Doppler effect in limiting the magnitude of power excursions in the SPERT III core at operating temperatures. Comparisons of calculations and experimental data demonstrate that PARET is capable of predicting power excursion behavior in SPERT III within experimental uncertainty for the range of conditions investigated. The SPERT III integral core tests also provide a broad base of experimental data for demonstrations of the capabilities of other existing models in predicting nondamaging power excursion behavior in UO_2 fueled reactors. 20 references. (auth)

28446 A SYSTEMATIC COMPARISON OF DIFFERENT HYDRODYNAMICS MODELS. Grumbach, Rainer (OECD Halden Reactor Project, Halden, Norway). Nucl. Sci. Eng., 36: 429-33(June 1969).

Possible approaches to the hydrodynamic calculations for static and dynamic behavior of boiling water reactor coolant channels are outlined. Characteristics of the various mathematical models are tabulated. Comparisons of experimental data and results are given. (M.L.S.)

28447 A DETAILED METHOD FOR CALCULATING THE LOW ENERGY MULTIGROUP CROSS SECTIONS AND THE DOPPLER COEFFICIENT IN A FAST REACTOR. Adkins, C. R. (Carnegie-Mellon Univ., Pittsburgh); Murley, T. E.; Dyos, M. W. Nucl. Sci. Eng., 36: 336-50(June 1969).

The well-known approximations used for finding multigroup cross sections and the Doppler coefficient are examined to determine their validity. The method involves comparing the approximate methods of one fast-reactor cross-section code (MC^2) with a more rigorous treatment which removes most of the approximations. The unresolved resonance region makes a considerable contribution to the Doppler coefficient in fast reactors, and this region is treated more precisely by generating pseudo resonances using random sampling techniques within the Breit–Wigner single level formalism. A procedure is developed which ensures that the generated pseudo resonances are consistent with measured pointwise data. The resonance data are used in an ultra-fine energy group integral transport-theory code which treats the space-dependent slowing down problem in a very precise manner. A numerical comparison between the approximate methods used in MC^2 and those used in the more rigorous calculations is made for a mixed carbide, Na-cooled fast breeder reactor. Aside from some very significant detailed differences, it is shown that the approximations used in MC^2 are not too severe, and that the code is adequate for determining the multigroup cross sections and the Doppler coefficient. The more rigorous method is a very time consuming and detailed procedure not well suited for design calculations. It is intended to serve as a standard, to which more approximate methods can be compared. 17 references. (auth)

Control Systems

28448 (LA-4123) DIGITAL COMPUTER FLOW RATE CONTROL SYSTEM. Demuth, Howard B. (Los Alamos Scientific Lab., N. Mex.). Oct. 1968. Contract W-7405-eng-36. 59p. Dep. CFSTI.

The application of the on-line computer system incorporated in the Ultra High Temperature Reactor Experiment is described. The primary and secondary coolant flow rate control is discussed in detail, with particular attention given to the control-system stability and reliability as shown by analysis, and by control system tests conducted during flow tests of the reactor coolant systems. The equipment associated with the control system, the computer programming, and program checking features, and test results are described. (auth)

28449 DEVELOPMENT OF REACTOR PROTECTION FROM THE VAK TO THE HDR. Peuster, Karl; Schruefer, Elmar. At. Strom, 15: 64-70(Apr. 1969). (In German).

The development of reactor protection systems in the case of four boiling water reactors in the Federal Republic of Germany: in the experimental atomic power station at Kahl (VAK), the nuclear power station of the RWE-Bayernwerk in Gundremmingen (KRB), the Lingen (KWL) nuclear power station and the superheating reactor at Grosswelzheim (HDR) is discussed. The voltage supply, the actuating circuits, the evaluation circuits and the magnetic valves are dealt with in detail. (auth)

28450 SYSTEMS CONSIDERATIONS IN THE DESIGN OF SODIUM PUMPS FOR LIQUID METAL FAST BREEDER REACTORS. Gunson, W. E.; George, J. A.; Horner, H. P.; Goeser, D. K. (Westinghouse Electric Corp., Madison, Pa.). Nucl. Appl., 6: 279-86(Apr. 1969).

Systems considerations influencing the design of vertical, centrifugal, and free surface pumps for Liquid Metal Fast Breeder Reactors are evaluated. Systems were analyzed to guide in selections for pumps with flow ranges of 10,000 to 200,000 gal/min and head ranges from 100 to 450 feet for both the sea-of-sodium and piped reactor arrangements. The system analyses defined the parametric relationships between the pump, the coolant system, and the overall plant requirements. The plant arrangement, piped or sea-of-sodium, affects the net positive suction head available, choice of pump location, the severity of the thermal transients, system pressure levels, and ease of operation and maintenance. (auth)

28451 IMPROVEMENTS RELATING TO CONTROL MEANS FOR FAST NUCLEAR REACTORS. Rinaldini, Carlo (to European Atomic Energy Community). British Patent 1,151,356 May 7, 1969. Filed Aug. 26, 1965.

Control means are described for a fast reactor having fuel rods arranged in parallel or substantially parallel relationship. The rods are pointed or tapered at least at one end. These tapered ends are held between the elements of a grid. The elements are independently movable transversely to the axes of the rods and held by an outer elastic or rupturable ring. On elongation of the rods due to thermal expansion the tapered ends move so as to increase the separation between the grid elements and consequently the lateral distances between the rods, at least at their tapered ends. The ring may have a weakened section which ruptures when a predetermined load is exceeded. The grid elements may be urged (by springs or gravity) lengthwise of the rods to enter between the rods and hence effect separation of the rods in the event of rupture of the holding ring. A second grid may be employed to hold the other end of the control rod. The lateral distance between the rods may thus be increased to bring the reactor to a state of prompt undercriticality. (UK)

28452 THEORY OF THE CORRELATION METHOD OF DYNAMIC ANALYSIS AND ITS APPLICATION TO INDUSTRIAL PROCESSES AND NUCLEAR POWER PLANT. Godfrey, K. R. (Warren Spring Lab., Stevenage, Eng.). Meas. Contr., 2: T65-T72(May 1969).

The theory of the time domain relationship between the input and output of a linear process is presented, and the mathematical relationships are explained and clarified by graphical illustration. The theory of the correlation method of process dynamic analysis is similarly presented. Special reference is made to the use of pseudo-random binary signals as perturbation signals, and a design procedure for crosscorrelation experiments with a pseudo-random binary perturbation signal is given. Tables listing experiments so far reported in the literature are included, and applications in the process industries and to nuclear power systems are considered. (auth)

28453 PRESSURE PULSE PROPAGATION IN AN ANNULAR FLOWING TWO-PHASE SYSTEM. Garrard, C. W. Jr.; Wick, R. S. (Texas A and M Univ., College Station). Nucl. Sci. Eng., 36: 427-9(June 1969).

Measurements of pulse propagation speeds in flowing two-phase annular flow systems are described. The experimental setup for the air-water system is shown. Void fraction is given as a function of pressure pulse speed and as a function of the ratio of pulse speed in the medium to sonic speed in gas. 11 references. (M.L.S.)

28454 ON TRANSIENT DIGITAL CONTROL OF A LINEAR MODEL OF THE HALDEN BOILING WATER REACTOR. Ciechanowicz, W.; Solberg, K. O. (Institutt for Atomenergi, Kjeller, Norway). Nucl. Sci. Eng., 36: 361-71(June 1969).

A theoretical check on the compromise in the control strategy design to decrease the required number of computations is described. Two types of HBWR control system models are investigated: one involves the control strategy calculation for the overall dynamic system; in the other case, the overall system is split into two systems characterized by smaller number of state variables. The interactions between the split systems are included by use of crosscoupling controller elements. The comparison between considered control models shows similar dynamic behavior of the investigated state variables. The main advantage of splitting the system is decreasing the order of state vectors taken into account in the control-strategy calculations. The constraint problem is considered by making use of Lagrange multiplier formalism and when the physical amplitude limitations are imposed on the controller signals. The comparison of both types of constraints shows that the latter is a quite satisfactory simplification in the constraint problem of the controller signals. The advantage of applying the physical limitation of the controller signal amplitude is that this type of constraint does not require the computer memory capacity for storage of the optimum trajectory space. (auth)

28455 CONTROL MECHANISMS FOR GAS COOLED REACTORS. Bowles, L. F. (English Electric Co. Ltd., Whetstone, Eng.). pp EN.1/37.1-11 of Symposium on the Technology of Integrated Primary Circuits for Power Reactors, Proceedings, Paris, 20th–22nd May 1968. Paris, European Nuclear Energy Agency, 1968.

See CONF-680525.

Various types of control rod drive mechanisms for integrated advanced gas-cooled power reactors with prestressed concrete pressure vessels are described. 3 references. (D.C.C.)

Cooling Systems

Refer also to abstracts 26450, 28411, and 28486.

28456 (AED-C-1-15) BIBLIOGRAPHIES IN NUCLEAR SCIENCE AND TECHNOLOGY. SECTION 1. CIVIL ENGINEERING. NUMBER 15. PRE-STRESSED CONCRETE PRESSURE VESSELS FOR REACTORS. (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). Jan. 1969. 82p. (In English and German). Dep.

A bibliography on prestressed concrete pressure vessels for reactors is given. Included are: 107 bibliographic citations to literature, an author index, journal index, and subject index. (M.L.S.)

28457 (AED-C-1-16) BIBLIOGRAPHIES IN NUCLEAR SCIENCE AND TECHNOLOGY. SECTION 1: CIVIL ENGINEERING. NUMBER 16. STEEL PRESSURE VESSELS FOR REACTORS. (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). Jan. 1969. 119p. (In English and German). Dep.

A bibliography on steel pressure vessels for reactors is given. Included are: 143 bibliographic citations for literature, an author index, a report index, a journal index, and a subject index. (M.L.S.)

28458 (APDA-234) QUARTERLY TECHNICAL PROGRESS REPORT ON AEC-SPONSORED ACTIVITIES, OCTOBER–DECEMBER 1968. (Atomic Power Development Associates, Inc., Detroit, Mich.). Contract AT(11-1)-865. 44p. Dep. CFSTI.

BOILERS—tubes for LMFBR, measurements of sodium-induced wastage of
HYDROGEN—content in LMFBR coolant sodium, description of loop and apparatus for determining
LIQUID METAL FAST BREEDER REACTOR—steam generators for, wastage measurements on tubes in mockups of
  —sodium coolant for, testing of rhometer, oxygen meter, and plugging meter for purity control of
  —sodium coolant for, results of centrifuge purification testing of
OXYGEN—concentration in LMFBR sodium coolant, ambient temperature coefficients for meters for determining
RHOMETERS—performance in LMFBR sodium coolant, effects of impurities on
SODIUM—purity control of LMFBR coolant, testing of rhometer, oxygen meter, and plugging meter for
  —purity of LMFBR coolant, failure of oscillating plugging meter for determining
  —purity of LMFBR coolant, results of centrifuge testing of
  —hydrogen content in LMFBR coolant, description of loop and apparatus for determining (M.L.S.)

28459 (EURAEC-2090) DEVELOPMENT PROGRAM ON THE APPLICATION OF STEAM-WATER SPRAY TO REACTOR COOLING. IN-PILE EXPERIMENTS ON STEAM-WATER MIXTURES: WATER CHEMISTRY. Topical Report No. 8. Cerrai, E.; Gadda, F.; Ronchetti, C.; Scaroni, A. (Centro Informazioni Studi Esperienze, Milan (Italy)). Dec. 1968. Contract 056-62-1-RDI. 60p. (EUR-4010; CISE-R-175). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

Experiments in the field of water chemistry of steam-water mixtures for use as coolants for the CIRENE reactor concept are reported. Two aspects were considered: formation of radioactive corrosion products; and production of radiolytic gases. Emphasis was on the effect on radiolytic gas production of parameters such as the presence of organic matter, the values of pH and conductivity, the concentration of H_2 and O_2, and the thermohydraulic conditions of the steam-water mixtures. The experiments were performed with a specially designed and built loop located on the Avogadro 1 pool reactor. (auth)

28460 (ORNL-4353, pp 141-278) PRESTRESSED-CONCRETE REACTOR PRESSURE VESSEL RESEARCH AND DEVELOPMENT. (Oak Ridge National Lab., Tenn.).

CONCRETES—creep in, effects of strain and time on uniaxial, biaxial, and triaxial
  —pressure vessels of prestressed, development for high temperature gas cooled reactors of
LIMESTONE—physical properties of crushed
PRESSURE VESSELS—development of high temperature gas-cooled power reactor prestressed concrete
  —mechanical properties of prestressed concrete, model analysis of
REACTORS, GAS-COOLED—pressure vessels for high temperature power, development of prestressed concrete
REACTORS, POWER—pressure vessels for gas-cooled high temperature, development of prestressed concrete
ROCKS—physical properties of crush aggregate (D.C.C.)

28461 (RD/B/N-1328) OPTIMISATION OF AXIAL RATING SHAPES [IN AGR's]. Freck, D. V.; Stratton, A. A. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Mar. 1969. 27p. Dep. CFSTI. UK.

By considering only thermal factors, ideal axial rating shapes to give maximum channel power or minimum channel length are derived. These act as standards against which the thermal performance of actual shapes may be judged. Numerical methods of calculating the channel power or channel length for any shape are given. A method for improving the thermal performance of a channel by altering the axial shape in stages is described. This may be used when adjusting enrichments axially. The analysis is in terms of nominal temperatures, but the extension of systematics is also formulated. (UK)

28462 PRESSURE VESSEL MADE OF PRESTRESSED CONCRETE AND METHOD OF PRESTRESSING SUCH A VESSEL. (to Philipp Holzmann Aktiengesellschaft). British Patent 1,150,797. Apr. 30, 1969. Priority date Aug. 26, 1966, Germany.

CONCRETES—prestressing of pressure vessel, use of releasable couples for multiple ring arranged cables in

PRESSURE VESSELS—use of releasable couples for multiple ring arranged cables in

REACTORS, GAS-COOLED—pressure vessel for graphite-moderated power, method for prestressing concrete

REACTORS, GRAPHITE-MODERATED—pressure vessel for gas-cooled power, method for prestressing concrete

REACTORS, POWER—pressure vessel for gas-cooled graphite-moderated, method for prestressing concrete (D.C.C.)

28463 BOILING-WATER REACTOR WITH FORCED CIRCULATION OF THE COOLANT. (to Licentia Patent-Verwaltungs-GmbH). British Patent 1,150,777. Apr. 30, 1969. Priority date July 23, 1965, Germany.

HEAT TRANSFER SYSTEMS—impellers in forced circulation boiling power reactor, description of downward flow

REACTORS, BOILING—cooling system for power, description of multiple downward flow impellers in forced circulation

REACTORS, POWER—cooling system for boiling, description of multiple downward flow impellers in forced circulation (D.C.C.)

28464 IMPROVEMENTS IN OR RELATING TO JET PUMPS AND NUCLEAR REACTOR PUMPING SYSTEMS. Howard, Charles Lewis (to General Electric Co.). British Patent 1,151,205. May 7, 1969. Priority date July 30, 1965, United States.

PUMPS—jet, description for boiling reactor of multiple reverse nozzle

REACTORS, BOILING—pumps for, description of multiple reverse flow nozzle jet (D.C.C.)

28465 DEMOUNTABLE COVER FOR A PRESTRESSED-CONCRETE VESSEL. Costes, Didier; Puyo, Andre (to Commissariat a l'Energie Atomique). British Patent 1,151,487. May 7, 1969. Priority date Apr. 28, 1967, France.

CONCRETES—pressure vessels of prestressed, description of removable cover for

PRESSURE VESSELS—cover for gas-cooled reactor prestressed concrete, description of removable overhead

REACTORS, GAS-COOLED—pressure vessels for, description of removable overhead cover for prestressed concrete (D.C.C.)

28466 STOCHASTIC METHODS OF HYDRODYNAMIC INSTABILITY STUDY OF REACTOR STEAM GENERATING CHANNELS. Seliverstov, B. N.; Gavrilov, P. A.; Bykov, Yu. M.; Shuinov, Yu. N. At. Energ. (USSR), 26: 319-24(Apr. 1969). (In Russian).

Hydrodynamic anomalies caused by coolant fluctuations in boiling reactor channels have been studied at a special rig with an independent heat source. It has been found that a correlation between the noise spectrum of steam void volume at the exit of a channel and stability margins of steam generating channels takes place. The deformation of the void volume noise spectrum has been recorded for the given thermal and hydraulic parameters in relation to the limits of the non-pulsing operation of steam generating channels. Then one of the parameter values has been changed in such a way as to make the locus of new conditions move to the instability limit. The experiment run was over when the stability limits were achieved, that is when coolant flow gradients in fuel channels were observed. The statistical properties of steam void noise in stability limits are characterized by a time-dependent correlation function; this is evidence of latent periodicity in steam void noise spectrum. (auth)

28467 REQUIREMENTS ON PRESSURE VESSEL STEEL. Schlochtermeyer, G. (Deutsche Babcock and Wilcox-Dampfkesselwerke AG, Oberhausen, Ger.); Spalthoff, W. pp 1-10 of Reaktordruckgefaess-Staehle und ihr Verhalten Unter Bestrahlung. Fischer, E.; Melkonian, G. A. (eds.). Muenchen, Verlag Karl Thiemig KG, 1968. (In German).

From Conference on Radiation Effects on Materials, Geesthacht, West Germany. See CONF-670336.

The requirements placed on the steel for reactor pressure vessels are summarized with special emphasis on the need for safety against brittle fracture and insensitivity to radiation damage. (J.S.R.)

28468 ENGINEERING STUDY FOR INTEGRATED PRESSURIZED WATER REACTOR. Braun, Howard E. (Westinghouse Electric Corp., Pittsburgh). pp EN.1/43.1-8 of Symposium on the Technology of Integrated Primary Circuits for Power Reactors, Proceedings, Paris, 20th-22nd May 1968. Paris, European Nuclear Energy Agency, 1968.

See CONF-680525.

A design study on integrated pressurized-water reactor systems with a prestressed concrete pressure vessel is described. Present pressurized-water reactor systems are analyzed. A comparison with the performance of present gas-cooled reactors is made for pressurized-water systems. (D.C.C.)

28469 SINGULARITY INVESTIGATIONS ON PCPV PENETRATIONS. Bremer, F. (Fried. Krupp GmbH, Essen). pp EN.1/13.1-12 of Symposium on the Technology of Integrated Primary Circuits for Power Reactors, Proceedings, Paris, 20th-22nd May 1968. Paris, European Nuclear Energy Agency, 1968.

See CONF-680525.

In connection with design and analysis of a HTGR prestressed concrete pressure vessel it was found indispensable to simulate the elastic behavior of the highly penetrated upper slab by use of equivalents of Young's moduli in computer stress analysis. There were two small size Makrolon slab models built and tested. To simulate the stiffening effect of the shutter tubes in the penetrations, one of the models had reduced hole diameters. Different strain gauge equipments have been used in reliance to differential penetration pitch and diameter. Loading and measuring devices are reported. Methods of investigation are described. Results for reinforced and unreinforced holes are given. (auth)

28470 THE PRESTRESSED CONCRETE PRESSURE VESSEL FOR A LARGE D_2O-REACTOR. Gruhl, Harald; Granzow, Klaus (Siemens-Schuckertwerke AG, Erlangen, Ger.). pp EN.1/19.1-14 of Symposium on the Technology of Integrated Primary Circuits for Power Reactors, Proceedings, Paris, 20th-22nd May 1968. Paris, European Nuclear Energy Agency, 1968.

See CONF-680525.

Design characteristics of the prestressed concrete pressure vessel for a proposed integrated 600 MW(e) heavy water-cooled reactor are described. 4 references. (D.C.C.)

28471 ENEL'S EXPERIENCE IN THE DESIGN OF PRESTRESSED CONCRETE PRESSURE VESSEL COMPONENTS. Bologna, P.; Morelli, V.; Pagani, G.; Scotto, F. (ENEL, Rome). pp EN.1/21.1-9 of Symposium on the Technology of Integrated Primary Circuits for Power Reactors, Proceedings, Paris, 20th-22nd May 1968. Paris, European Nuclear Energy Agency, 1968.

See CONF-680525.

The design and functional characteristics of integrated primary circuits for gas-cooled reactors are presented. Special reference is made to the metal lines, heat insulation, and concrete cooling system. The behavior of the lines is analyzed from the standpoint of safety and ultimate strength of the pressure vessel. (D.C.C.)

28472 METAL FOIL INSULATION FOR PRESTRESSED CONCRETE PRESSURE VESSELS FOR WATER REACTORS. Alexander, B.; Ringstad, B.; Skinstad, A. (Aktiebolaget Atomenergi, Stockholm). pp EN.1/24.1-13 of Symposium on the Technology of Integrated Primary Circuits for Power Reactors, Proceedings, Paris, 20th-22nd May 1968. Paris, European Nuclear Energy Agency, 1968.

See CONF-680525.

Design characteristics of metal foil thermal insulation for boiling water reactor prestressed concrete pressure vessel are described. 3 references. (D.C.C.)

28473 THERMAL INSULATION AND PRESSURE VESSEL COOLING FOR GAS-COOLED REACTORS. Staley, J. F. W. (Darchem Engineering Ltd., Stillington, Eng.); Turton, P. J. pp EN.1/33.1-15 of Symposium on the Technology of Integrated Primary Circuits for Power Reactors, Proceedings, Paris, 20th-22nd May 1968. Paris, European Nuclear Energy Agency, 1968.

See CONF-680525.

Optimum design characteristics for thermal insulation of prestressed concrete pressure vessels for gas-cooled power reactors are described. The insulation consists of lined membrane and multiple water cooled pipes. 5 references. (D.C.C.)

28474 THE IMPLICATIONS OF THE POD-BOILER AGR CIRCUIT ON VESSELS, PENETRATIONS, AND PRE-STRESSING. Burrow, R. E. D. (Taylor Woodrow Construction Ltd., Southall, Eng.); Williams, A. J. pp EN.1/38.1-16 of Symposium on the Technology of Integrated Primary Circuits for Power Reactors,

Proceedings, Paris, 20th–22nd May 1968. Paris, European Nuclear Energy Agency, 1968.
See CONF-680525.

The effects of pod-arranged boilers on the design of the prestressed concrete pressure vessel and the components forming the cooling system for an advanced gas-cooled power reactor are described. The general design considerations include: liner penetrations and cooling system; the hot-box dome; and insulation. Stress analysis of the prestressed concrete pressure vessel is discussed. The construction sequence is listed. 3 references. (D.C.C.)

28475 MAIN COOLING CIRCUIT OF A HEAVY WATER MODERATED AND COOLED REACTOR WITH PRESTRESSED CONCRETE PRESSURE VESSEL. Bortolazzi, K.; Frei, G.; Stueger, R. (Siemens Aktiengesellschaft, Erlangen, Ger.). pp EN.1/18.1-12 of Symposium on the Technology of Integrated Primary Circuits for Power Reactors, Proceedings, Paris, 20th–22nd May 1968. Paris, European Nuclear Energy Agency, 1968.
See CONF-680525.

Design parameters required for the primary cooling system of a heavy water-cooled and -moderated power reactor with a prestressed concrete pressure vessel are analyzed. The flow diagrams for a 600 MW(e) system are presented. 3 references. (D.C.C.)

28476 PRIMARY CIRCUIT OF THE 300 MWe THTR PROTOTYPE REACTOR. Schmiedel, F. (Brown Boveri/Krupp Reaktorbau GmbH, Mannheim, Ger.). pp EN.1/14.1-11 of Symposium on the Technology of Integrated Primary Circuits for Power Reactors, Proceedings, Paris, 20th–22nd May 1968. Paris, European Nuclear Energy Agency, 1968.
See CONF-680525.

Design parameters for the 300 MW(e) Thorium High-Temperature Reactor are presented. Technical specifications for the primary cooling system are described. (D.C.C.)

28477 INTEGRATED PRIMARY CIRCUITS WITH INDIVIDUALLY REMOVABLE BOILER UNITS FOR HIGH TEMPERATURE GAS COOLED REACTORS. Dean, J. R.; Kinkead, A. N.; McIver, R. F. (Atomic Energy Establishment, Dorset, Eng.). pp EN.1/39.1-21 of Symposium on the Technology of Integrated Primary Circuits for Power Reactors, Proceedings, Paris, 20th–22nd May 1968. Paris, European Nuclear Energy Agency, 1968.
See CONF-680525.

Design problems related to boiler configurations in integrated high-temperature gas-cooled power reactors are described. The safety characteristics for integrated high-temperature gas-cooled power reactors are analyzed. 15 references. (D.C.C.)

28478 SOME DESIGN ASPECTS OF INTEGRATED STEAM GENERATORS FOR GAS-COOLED REACTORS. Fritz, K. (Waagner-Biro AG, Vienna). pp EN.1/1.1-19 of Symposium on the Technology of Integrated Primary Circuits for Power Reactors, Proceedings, Paris, 20th–22nd May 1968. Paris, European Nuclear Energy Agency, 1968.
See CONF-680525.

Design parameters for various types of boilers in integrated gas-cooled power reactors are presented. The problems with boiler configuration are described. Various types of boiler arrangements are discussed. 16 references. (D.C.C.)

28479 POSSIBLE SOLUTIONS FOR INTEGRATED STEAM GENERATORS OF THE THTR. Hennings, U. (Brown Boveri/Krupp, Mannheim, Ger.). pp EN.1/16.1-22 of Symposium on the Technology of Integrated Primary Circuits for Power Reactors, Proceedings, Paris, 20th–22nd May 1968. Paris, European Nuclear Energy Agency, 1968.
See CONF-680525.

Design requirements for the integrated boiler of the 300 MW(e) Thorium High-Temperature Reactor are described. (D.C.C.)

28480 COMPACT STEAM GENERATOR FOR STEAM COOLED FAST BREEDER REACTORS. Dillstroem, G. (Aktiebolaget Atomenergi, Stockholm). pp EN.1/27.1-7 of Symposium on the Technology of Integrated Primary Circuits for Power Reactors, Proceedings, Paris, 20th–22nd May 1968. Paris, European Nuclear Energy Agency, 1968.
See CONF-680525.

Experimental results of the performance of a spray type boiler for an integrated steam-cooled fast breeder reactor are analyzed. (D.C.C.)

28481 BOILERS FOR ADVANCED GAS COOLED REACTORS. Merrett, D. J. (Atomic Power Constructions Ltd., Sutton, Eng.); Shaw, T. pp EN.1/32.1-17 of Symposium on the Technology of Integrated Primary Circuits for Power Reactors, Proceedings, Paris, 20th–22nd May 1968. Paris, European Nuclear Energy Agency, 1968.
See CONF-680525.

The engineering and economic factors are described which regulate the design parameters of boilers for 600 MW(e) integrated gas-cooled reactors with prestressed concrete pressure vessels. Future trends in gas-cooled reactor designs are discussed. (D.C.C.)

28482 THE POD BOILER AGR CIRCUIT. Seymour, D. F. (Nuclear Design and Construction Ltd., Whetstone, Eng.). pp EN.1/34.1-17 of Symposium on the Technology of Integrated Primary Circuits for Power Reactors, Proceedings, Paris, 20th–22nd May 1968. Paris, European Nuclear Energy Agency, 1968.
See CONF-680525.

Advantages and disadvantages of advanced gas-cooled power reactor systems are compared. Basic design parameters for CO$_2$-cooled power reactors are described. The pod boiler configuration for advanced gas-cooled reactors is illustrated. (D.C.C.)

28483 IMPROVEMENTS IN MODERATOR CORE STRUCTURES FOR NUCLEAR REACTORS. Triggs, Geoffrey William; Prince, Norman (to United Kingdom Atomic Energy Authority). British Patent 1,150,729. Apr. 30, 1969. Filed July 28, 1965.

A gas-cooled graphite-moderated reactor is described in which the coolant flowing through the core is divided into two independent streams—a fuel coolant stream in fuel cooling channels, and a moderator coolant stream in moderator cooling channels. The moderator coolant stream joins the fuel coolant stream inside the core near the fuel coolant inlet. The core support structure need be contacted only by relatively cool gas feeding the fuel element channels, thus simplifying thermal expansion problems. In a preferred form the moderator and fuel coolant streams join in a voidage space extending across the core structure, this space being open to the moderator stream and having outlet ports joining with the fuel stream. The moderator stream thus makes a significant contribution to the coolant flow through the fuel element channels, and the provision of the voidage space assists in avoiding serious lack of coolant flow in adjacent fuel element channels when the fuel elements are discharged from any particular channel. The reactor may be supported on a base grid and arranged so that coolant flows downward through the moderator channels and upwards through the fuel channels; coolant which has passed through the moderator channels joins coolant entering the fuel channels without traversing the base grid; or coolant entering the fuel channels has traversed the base grid. (UK)

Fuels

Refer also to abstract 27147.

28484 (AERE-Trans-1109) CALCULATION OF BUILD-UP AND RELEASE RATES OF VARIOUS NUCLIDES FROM A UO$_2$ FUEL ELEMENT. Cenacchi, G.; Segre, G. J. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). Translated by C. R. Brightmore (Atomic Energy Research Establishment, Harwell, Eng.), from report RT/FIMA-(67)2. 23p. Dep. CFSTI. UK 3s. 6d.

Calculations are presented of the buildup and release rates of some nuclides which appeared to be the most deserving of study on the basis of chemical and physical considerations, in relation to fast reactor fuel elements. It is pointed out that the mathematical formulation of the problem leads to very complicated equations involving some unknown physical constants and some poorly known phenomena, such as the adsorption and absorption of gases on the oxide surface. A simplified model is used, employing hypotheses which are explained. 8 references. (UK)

28485 (NP-17556(App.)) ILLUSTRATIVE POWER REACTOR PROGRAMMES. (European Nuclear Energy Agency, Paris (France)). May 1968. 49p. Dep.

Appendices contain information on: Pu, Th, and U requirements during 1990, 2000, and 2010; effects of fabrication and reprocessing capabilities on fuel economics for 2001 to 2010; and summaries of computer programs for forecast requirements. (D.C.C.)

28486 (ORNL-4353) GAS-COOLED REACTOR PROGRAM SEMIANNUAL PROGRESS REPORT FOR PERIOD ENDING SEPTEMBER 30, 1968. Savolainen, Ann W. (comp. and ed.) (Oak Ridge National Lab., Tenn.). Mar. 1969. Contract W-7405-eng-26. 283p. Dep. CFSTI.

Information concerning the development of high-temperature gas-cooled reactors is presented. General topics discussed include: high-temperature gas-cooled reactor development; gas-cooled fast reactor development; and prestressed-concrete reactor pressure vessel research and development. Separate abstracts are included for each of the 3 sections presented. (D.C.C.)

For abstracts of individual sections see: 28487, 28460, and 28488.

28487 (ORNL–4353, pp 1-109) HIGH-TEMPERATURE GAS-COOLED REACTOR DEVELOPMENT. (Oak Ridge National Lab., Tenn.).

CHROMIUM ALLOYS AND SYSTEMS—Cr–Mo, welding properties of, effects of steam temperature and time on
FISSION PRODUCTS—release from beds of bonded, (E/T)
HASTELLOY X—welding properties of, effects of steam temperature and time on
INCOLOY 800—welding properties of, effects of steam temperature and time on
INCONEL 82—welding properties of, effects of steam temperature and time on
INCONEL 600—welding properties of, effects of steam temperature and time on
INCONEL 625—welding properties of, effects of steam temperature and time on
IODINE ISOTOPES I-131—release from failed pyrolytic carbon coated uranium oxide (UO_2) and uranium carbide (UC_2) particles of, effects of
MOLYBDENUM ALLOYS AND SYSTEMS—Cr–Mo, welding properties of, effects of steam temperature and time on
NEUTRONS, FAST—effects on physical properties of bonded bed pyrolytic carbon coated uranium oxide (UO_2) and uranium carbide (UC_2) particle type fuel elements
—effects on physical properties of bonded bed pyrolytic carbon coated sphere shaped zirconium oxide (ZrO_2)
RADIATION TARGET CANS—design of HTGR-HFTR HT3, for fast neutron effects on bonded
—design of HTGR-HFTR HRB5-1, for fast neutron effects on bonded bed pyrolytic carbon coated sphere shaped mixed oxides, mixed carbides, and zirconium oxide (ZrO_2)
REACTOR FUEL ELEMENTS—radiation effects on physical properties of bonded bed pyrolytic carbon coated uranium oxide (UO_2) and uranium carbide (UC_2) particle type, measurement of fast neutron
—oxidation of high temperature gas-cooled reactor bonded bed stick type, test facility for steam
REACTORS, GAS-COOLED—fuel elements for high temperature power, radiation effects on bonded bed pyrolytic carbon coated uranium oxide (UO_2) and uranium carbide (UC_2) particle type
—fuel cycle characteristics of high temperature power, analysis of optimum economic
REACTORS, POWER—fuel elements for gas-cooled high temperature, radiation effects on bonded bed pyrolytic carbon coated uranium oxide (UO_2) and uranium carbide (UC_2) particle type
—fuel cycle characteristics of gas-cooled high temperature, analysis of optimum economic
SEALS AND GLANDS—development of high temperature gas-cooled power reactor rotating shaft visco, (T)
URANIUM CARBIDES—radiation effects on physical properties of pyrolytic carbon coated sphere shaped, measurement of fast neutron
URANIUM OXIDES UO_2—radiation effects on physical properties of pyrolytic carbon coated sphere shaped, measurement of fast neutron
WELDS—mechanical properties of nickel alloy, for high temperature gas-cooled reactor steam generators
ZIRCONIUM OXIDES—radiation effects on physical properties of bonded bed pyrolytic carbon coated sphere shaped, measurement of fast neutron (D.C.C.)

28488 (ORNL–4353, pp 111-39) GAS-COOLED FAST REACTOR DEVELOPMENT. (Oak Ridge National Lab., Tenn.).

NEUTRONS, FAST—effects on physical properties of plutonium oxide (PuO_2)–uranium oxide (UO_2) and uranium oxide (UO_2) pellet type fuel elements
PLUTONIUM OXIDES PuO_2—PuO_2–UO_2, radiation effects on physical properties of pellet shaped, measurement of fast neutron
REACTOR FUEL ELEMENTS—radiation effects on physical properties of plutonium oxide (PuO_2)–uranium oxide (UO_2) and uranium oxide (UO_2) pellet type, measurement of fast neutron
—heat transfer characteristics of gas-cooled spirally corrugated, effects of configuration on
REACTORS, FAST—fuel elements for gas-cooled power, radiation effects on plutonium oxide (PuO_2)–uranium oxide (UO_2) and uranium oxide (UO_2) pellet type
REACTORS, GAS-COOLED—fuel elements for fast power, radiation effects on plutonium oxide (PuO_2)–uranium oxide (UO_2) and uranium oxide (UO_2) pellet type
REACTORS, POWER—fuel elements for gas-cooled fast, radiation effects on plutonium oxide (PuO_2)–uranium oxide (UO_2) and uranium oxide (UO_2) pellet type
URANIUM OXIDES UO_2—PuO_2–UO_2, radiation effects on physical properties of pellet shaped, measurement of fast neutron
—radiation effects on physical properties of pellet shaped, measurement of fast neutron (D.C.C.)

28489 CONSIDERATIONS IN THE PURCHASE OF REPLACEMENT FUEL FOR WATER REACTORS. Crawford, W. Donham (Consolidated Edison Co. of New York, Inc., New York); Dragoumis, Paul; Tribble, J. E. Proc. Amer. Power Conf., 30: 223-7(1969).

From 30th Annual American Power Conference, Chicago, Ill. See CONF-680418.

Minimization of fuel cycle technical and economic risks for the utility is discussed. Disadvantages of minimizing risks are listed. Minimum supply services and fuel warranties are described. (M.L.S.)

28490 POWER REACTOR FUEL SUPPLIES AND SERVICES OF THE U.K.A.E.A. Waddams, J. A. pp 44-6 of British Nuclear Power Plant. [Proceedings of the] Bangkok Symposium, November 1968. London, British Nuclear Export Executive. Bangkok, Office of Atomic Energy for Peace, 1968.

See CONF-681125.

The various components of the fuel service, and facilities which are available at Springfields, Capenhurst, and Windscale are described. (UK)

28491 HIGHER POWER DENSITIES IN WATER REACTORS: ECONOMIC AND TECHNICAL BASES. Gallagher, William J.; McLeod, N. Barrie (NUS Corp., Rockville, Md.). Reactor Fuel-Process. Technol., 12: No. 1, 98-113(Winter 1968–69).

The relation between design criteria of no fuel damage and design practices is described. Design limits, including burnout and fuel center melting, and design margins are discussed and examined from the viewpoint of potential for further improvement in power density. A target of 10% increase in power density is used for purposes of illustration. It is demonstrated, in the case of the heat-transfer limitation (the usual limit), that most factors require an approximate 20% improvement in order to yield a 10% average power-density improvement. In the case of the center-melting limit, a 10% improvement in the factors yields a 10% power-density improvement. 2 references. (auth)

Auxiliary and Emergency Systems

28492 (SNE–50) INVESTIGATION OF THE USE OF AQUEOUS SOLUTIONS AS EMERGENCY COOLANTS. Final Report. McCullough, C. Rogers; Brown, Gilbert M.; Hancock, R. P.; Turner, S. E. (Southern Nuclear Engineering, Inc., Dunedin, Fla.). Mar. 31, 1969. Contract AT(40-1)-3749. 129p. Dep. CFSTI.

The testing of aqueous solutions or coolants other than water for use in water-cooled reactor emergency core cooling systems is described. The properties and performances of 23 selected chemical additives are presented. Experimental apparatus is described. 30 references. (D.C.C.)

28493 NUCLEAR REACTORS. Pugh, Derrick Owen; Booth, David Lawry (to English Electric Co. Ltd.). British Patent 1,150,387. Apr. 30, 1969. Filed Sept. 9, 1966.

A system is described to suppress coolant loss pressures in boiling reactors. A secondary vault is provided containing a "suppression pond" and substances which react with the atmosphere of the primary vault to produce non-gaseous products, when due to pressure increase, atmosphere from the primary vault is forced through the liquid in the secondary vault. The atmosphere in the primary vault may be air, CO_2, NH_3, etc. and the reacting substance in the secondary vault may be a soluble hydroxide, NO, etc. Separating means, such as an oil film, are provided between the liquid in the secondary vault and its atmosphere under normal operating conditions. (UK)

28494 DEVICE FOR DELAYING THE LOSS OF REACTOR COOLANT WATER. Ishikawa, Michio (to Japan Atomic Energy Research Inst.). Japanese Patent 1969-76. Jan. 6, 1969. Filed Sept. 8, 1966.

By the method proposed, the loss of coolant water in a reactor accident can be delayed. Within the opening of a pipe in a forced-circulation reactor, a member consisting of narrow slits, wire nets or the like is installed. When coolant water is ejected from the reactor due to a rupture of the piping, the outflow of coolant water is vaporized at the member, thereby delaying the loss of coolant in the reactor. (NSA of Japan)

28495 NUCLEAR REACTORS. Booth, David Lawry; Pugh, Derrick Owen (to English Electric Co. Ltd.). British Patent 1,151,334. May. 7, 1969. Filed Apr. 1, 1966.

If a breach occurs in the coolant circuit of a boiling reactor, radioactive vapour will escape into the surrounding reactor space, and the escaping vapour will increase the pressure in the reactor space. In order to release this pressure a leaktight space ("suppression vault") may be provided, in communication with the reactor space through a quantity of liquid referred to as a "suppression pond." The escaping vapour is condensed in the "suppression pond," the surface of which is free, so as to ensure that the pressure in the reactor space is normally about the same as in the "suppression vault." In this arrangement problems arise concerning containment and shielding during refuelling operations. when the interior of the coolant circuit is exposed. The reactor space and refuelling vault are in communication only through a "refuelling pond," so that the abnormal pressure can be relieved from the reactor space to the refuelling vault through this second pond. The reactor space and the refuelling vault may be separated by the roof of the reactor space. The pond is contained in a tank above the reactor core. The roof extends downward into the tank below the pond surface, so that the parts of the pond surface outside and inside the downwardly extending portion are in communication respectively with the reactor space and the vault. A further arrangement is to use a single pond to serve for refuelling and also to condense escaped vapour. (UK)

Operation and Economics

28496 AN OPTIMIZATION ANALYSIS FOR FUEL REPLACEMENT IN LARGE PRESSURIZED WATER REACTORS. Fagan, John Robert. Lafayette, Ind., Purdue Univ., 1968. 157p.
Thesis.

The subject of nuclear fuel management has recently taken on a great significance because nuclear fuels are proving competitive and even superior in some circumstance to fossil fuels in large central station power plants. This work considers economic optimization of one portion of the fuel cycle—fuel replacement in an existing reactor. Direct optimization of the fuel replacement problem has proven mathematically intractable to date mainly because of the very large number of variables involved. To define a precise fuel replacement scheme requires consideration of several hundred fuel elements for each of the 30-50 fuel replacement cycles of the plant lifetime. To reduce the problem to a manageable level two primary assumptions are used. First, it is assumed that nearly identical equilibrium cycles occurred throughout the majority of the plant lifetime and second, that all the significant operating parameters of the reactor system can be represented by a single time dependent parameter for each fuel element. The further assumptions are made that a single fuel feed enrichment is used and that the same number of fuel elements are replaced each cycle. Under these conditions sequences of equilibrium cycles are calculated which differ in length by at most 5%. The operating state model used to predict the reactor operating characteristics such as burnup and reactivity limited cycle lifetime, heavy isotope concentrations and accumulative burnup level for each fuel element proved accurate to within approximately 10%. Based upon this operating state model, direct fuel replacement and replacement with shuffling are evaluated. In both cases the refueling scheme is defined by optimizing the operating time for the cycle. It is shown that for the conditions assumed this is a good approximation of the economic optimization. The direct refueling scheme considered specifically the possibility of replacing integer numbers of fuel elements between the simple replacement fractions (i.e., ½, ¼, ⅓ of the total elements in the core) which can be calculated by conventional equilibrium cycle techniques. Unfortunately, the scatter in the fuel cycle costs, resulting principally from inaccuracies in the equilibrium cycle assumption, were larger than the variation in cost being sought. Shuffle refueling did show fuel cycle advantages of approximately 0.05 mills/Kw-hr which amounts to over $300,000 per year for a 1000 MW(e) plant. This is basically because of an increase in operating time for the same amount of new fuel. In this scheme the new fuel always replaced the most highly irradiated elements in the reactor. After the new elements were added to the core, the elements were shuffled until they yielded the maximum operating time consistent with the constraints on power distribution. The operating cycle times for shuffle refueling varied by less than 1.2% assuring the accuracy of the equilibrium cycle assumption. (Disser. Abstr.)

28497 NEW-FORM TECHNICAL SPECIFICATIONS AS APPLIED TO FIRST-GENERATION NUCLEAR POWER PLANTS. Tuite, P.; Lobbin, F.; Anderson, C. (Hittman Associates, Inc., Columbia, Md.). Reactor Fuel-Process. Technol., 12: No. 1, 43-54(Winter 1968-69).

New federal regulations governing the conditions under which nuclear power plants will be operated by a licensee became effective in January 1969. These new regulations and guidelines are compared to those used to prepare the first-generation plant Technical Specifications. The major problems in revising these early plant Technical Specifications are discussed, and the conduct of a revision effort for the N. S. Savannah reactor is described. (H.D.R.)

28498 ECONOMIC ASSESSMENT OF REACTOR COMPONENTS IN INTEGRATED SYSTEMS. Schultz, W.; Dietrich, R. (Brown Boveri/Krupp Reaktorbau GmbH, Mannheim, Ger.). pp EN.1/15.1-10 of Symposium on the Technology of Integrated Primary Circuits for Power Reactors, Proceedings, Paris, 20th-22nd May 1968. Paris, European Nuclear Energy Agency, 1968.
See CONF-680525.

The economic factors involved in designing integrated gas-cooled power reactors are analyzed. Data for the Thorium High-Temperature Reactor are presented for economic feasibility analysis. Problems related to the economics of integrated gas-cooled reactors are discussed. (D.C.C.)

28499 GUIDE TO NUCLEAR ECONOMICS. Eastwood, D. C. pp 47-61 of British Nuclear Power Plant. [Proceedings of the] Bangkok Symposium, November 1968. London, British Nuclear Export Executive. Bangkok, Office of Atomic Energy for Peace, 1968.
See CONF-681125.

An attempt is made to place the full range of economic appraisal into perspective. Particular attention is paid to those types of appraisal for which the customer most depends on information from the nuclear plant supplier. Illustrations are drawn from the experience of British utilities and the British nuclear industry. (UK)

28500 FAST REACTOR BLANKET MANAGEMENT. Tilford, James Madison. Lafayette, Ind., Purdue Univ., 1968. 289p.
Thesis.

An investigation was undertaken in order to determine an optimum blanket management scheme. Three types of radial blankets were considered: a one-batch stationary blanket, an in-out cycle, and an out-in cycle. The 1000-MW(e) Karlsruhe Na-1 Fast Breeder Reactor was chosen as the reference reactor for this study because it is typical of present-day fast breeder concepts. This system is fueled with uranium—plutonium oxide, sodium cooled, and contains a natural UO_2 radial blanket. The physical analyses of the three blanket management schemes were based upon a continuous blanket cycle model. This model assumes that the blanket material is continuously loaded at one blanket boundary, and moved continuously toward the other boundary where it is removed. The blanket lifetime is defined in terms of the constant volumetric flow rate of the blanket material. Actually, this represents the optimum case of blanket cycling. The physical computations were performed by the Continuous Fuel Cycle Code. The results of the physical analyses indicate that the out-in and in-out blanket cycles have more favorable ^{239}Pu distributions than the stationary blanket. This advantage results in lower heat generation and burnup rates, less neutron leakage and larger breeding ratios than for the stationary case. A further advantage of the cycled blankets is the large amount of ^{239}Pu which is bred in the blanket, thus increasing the plutonium credit. An economic analysis performed for each management scheme indicated that there exists a blanket lifetime which maximizes the blanket profit for each scheme. The study showed that for the conditions assumed the maximum profit for the out-in cycle is 0.0949 mills/kw-hr at a blanket lifetime of 1800 days. The corresponding maximum profits for the stationary and in-out blankets are 0.0580 and 0.0522 mills/kw-hr lifetimes of 1560 and 1410 days, respectively. Variations in the blanket profit for different blanket thicknesses, values of fissile plutonium, and fabrication and reprocessing costs were computed. In every case, the out-in cycle indicated much larger profits than either the stationary or in-out blanket management schemes. The overall advantages of the out-in scheme include larger blanket cycle profits and a longer optimal lifetime. This scheme also exhibits moderate maximum heat generation and burnup rates. (Disser. Abstr.)

Safety and Siting

Refer also to abstracts 26482, 26483, 26605, and 28536.

28501 (AHSB(S)R-159) METHODS FOR THE EVALUATION OF RISK. Beattie, J. R.; Bell, G. D.; Edwards, J. E. (United

Kingdom Atomic Energy Authority, Risley (England). Authority Health and Safety Branch). 1969. 39p. Dep. CFSTI. UK.

Mathematical methods are presented which have been used in estimating the risk to the population distribution surrounding a hypothetical large power reactor. The reactor is assumed to satisfy a control curve of the Farmer type relating the activity released in a given range of curies on a logarithmic scale to the probability that the release will occur. Results are presented for cases in which ^{131}I is imagined to have been released, and these take the form of curves relating numbers of cases of thyroid cancer to the probability that the number lies in a given range also on a logarithmic scale. After a general mathematical solution has been derived, a variety of particular solutions are examined which reveal or illustrate the effect of the release control curve, the dose-risk curve for the individual, and the population distribution for the site, upon the form of the frequency-casualty curve (in this case the f-N curve, where N is the number of cases). A practical method for computing risk, using the population figures and meteorological data for a site, is given, including an outline of the "STRAP" program for this purpose. f-N curves derived in this way are given for seven population distributions and general conclusions regarding comparative risks are discussed. (auth) (UK)

28502 (AHSB(S)R-160) QUANTITATIVE APPROACH TO THE EVALUATION OF THE SAFETY FUNCTION OF OPERATORS ON NUCLEAR REACTORS. Ablitt, J. F. (United Kingdom Atomic Energy Authority, Risley (England). Authority Health and Safety Branch). 1969. 28p. Dep.

Human factors which may influence events leading to a reactor accident are considered. The effects of certain factors are illustrated by examples which incorporate them and in which a quantitative treatment is introduced. Available data are sufficient to establish the principle of including the operator in a probability diagram. (UK)

28503 (BMI-1861) EVALUATION OF THE APPLICABILITY OF EXISTING DATA TO THE ANALYTICAL DESCRIPTION OF A NUCLEAR-REACTOR ACCIDENT. Quarterly Progress Report, January-March 1969. Morrison, David L.; Carbiener, Wayne A.; Ritzman, Robert L. (Battelle Memorial Inst., Columbus, Ohio). Apr. 1969. Contract W-7405-eng-92. 44p. Dep. CFSTI.

Long term core recovery cooling requirements are discussed; cooling requirements for crumbled cores in BWR systems are defined. Heat transfer and pressure drop equations are given for an isolated crumbled fuel mass; effects of slip ratio on the gravitational head are considered. Crumbled fuel height is shown as a function of coolant exit quality and power level. The mathematical model for forced convection cooling of a partially crumbled core is given; equations for heat balance between the fission product decay heat and the coolant enthalpy change are included. Pressure drop, power level, and boiling effects on coolant evaporation are evaluated. The formulation of a physical model for determining fuel cladding behavior under coolant loss accidents is described. Fission product chemical groups are tabulated; fission products are ranked according to relative hazard. Heat transfer data for core emergency cooling are compared; cooldown rates and heat transfer coefficients are shown as a function of fuel assembly height. 25 references. (M.L.S.)

28504 (EUR-4101) MEETING OF EXPERTS ON SHOCK STRUCTURE INTERACTIONS IN REACTOR VESSELS, ISPRA, ITALY, JUNE 27-30, 1966. (European Nuclear Energy Agency, Paris (France). (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Oct. 1968. 411p. (In French and English). (CONF-660669). UK $10.00.

Included are 17 papers on pressure wave initiation and propagation mechanisms, instruments for measurements in rapid transients, and shock effects on structures. A separate abstract was prepared for each of 16 papers. One paper was previously abstracted for NSA and appears under CONF-660669 in the report number index. (H.D.R.)

For abstracts of individual papers see: 26482, 26490, 26605, 27046–27048, 28505–28511, 28536, 28553, and 28554.

28505 (EUR-4101, pp 9-22) DEPRESSURISATION AND WAVE PROPAGATION IN WATER COOLED REACTORS. Edwards, A. R. (United Kingdom Atomic Energy Authority, Risley (England). [Authority Health and Safety Branch]).

Outlined are the areas where depressurization of a high temperature water reactor cooling system could have serious effects on internal and external reactor components. The uncertainties that exist on pressure wave propagation velocities are indicated, and investigations of the phenomena are outlined. The interpretation of model results and the effects of scale are discussed. Theoretical model treatments of wave propagation phenomena are briefly reviewed. 9 references. (H.D.R.)

28506 (EUR-4101, pp 23-74) SOME THEORETICAL CONSIDERATIONS AND EXPERIMENTAL DATA ON PROPAGATION AND REFLECTION OF UNDERWATER PRESSURE AND SHOCK WAVES. Holtbecker, H.; Maserati, A. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center).

Modes of propagation of waves due to rapid pressure rises are examined for cylindrical propagation geometry. The aspects of main interest are how a pressure wave decays during propagation and what values the pressure reaches if the wave is reflected from a structure. Propagation phenomena are discussed in three sections. The first concerns wave propagation from source to structure. The second studies wave behavior from the moment of impact on a structure. The third, dealing with events that occur when a wave impinges on a reactor channel, considers the shadow phenomena due to the tube, the diffraction of the wave, wave enhancement as a result of travel through the pressure tube reactor lattice, and the reflection from a pressure tube. 21 references. (H.D.R.)

28507 (EUR-4101, pp 75-88) SHOCK WAVES AND TRANSIENT LOADING FROM CHEMICAL REACTIONS. Moore, J. G. (United Kingdom Atomic Energy Authority, Risley (England). [Authority Health and Safety Branch]).

Shock waves and transient loading from chemical reactions in Na cooled and water cooled reactors are discussed. The design problems which may arise from transient loading of reactor enclosures are examined for a Na–air reaction and for the explosion hazard following a metal–water reaction which will liberate H_2. The hazard from shock pressures associated with a Na–water reaction in a Na heated steam generator is discussed. 5 references. (H.D.R.)

28508 (EUR-4101, pp 89-123) WATER DEPRESSURISATION STUDIES. Zaker, T. A.; Wiedermann, A. H. (IIT Research Inst., Chicago, Ill.).

Sudden rupture of a pressure tube in a pressurized water reactor leads to a depressurization or blowdown process accompanied by transient wave propagation through the system. Water-driven shock tube equipment used in depressurization experiments and some observations on blowdown phenomena are presented. Some theoretical studies of the transient phenomena in one-dimensional depressurizing systems are described. 5 references. (H.D.R.)

28509 (EUR-4101, pp 143-51) MODEL TECHNIQUES IN REACTOR ACCIDENT SIMULATION. Thumpston, N. S. (Atomic Weapons Research Establishment, Foulness (England)).

The types of scale models used in the U. K. for assessing the mechanical damage to reactor components and structures under accident conditions are described. Scaling factors and instrumentation used are discussed. Model studies involving energy insertion by pressurized gas, by electrical pulse heating, and by explosive charge are reviewed. (H.D.R.)

28510 (EUR-4101, pp 324-44) MECHANICAL EFFECTS OF THE RUPTURE OF A PRESSURE TUBE FROM GAS UNDER PRESSURE IN A REACTOR OF THE EL4 TYPE. Roche, R. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). (In French).

The characteristics of pressure tube and moderator tank construction in a reactor of the EL4 type are described. Safety consequences of rupture of a pressure tube are discussed. Test procedures and results are presented on the behavior of adjacent tubes and on the behavior of the reactor tank following a tube rupture. An analysis of the test data indicates that for tubes of the EL4 type there is no risk that a rupture will cause adjacent tubes to rupture and that by suitable dimensioning the tank will survive a tube rupture accident. 10 references. (H.D.R.)

28511 (EUR-4101, pp 379-91) CALCULATION OF THE RESPONSE OF MODEL AND FULL SCALE REACTOR STRUCTURES TO DYNAMIC LOADINGS. Rees, N. J. M. (Atomic Weapons Research Establishment, Foulness (England)).

The $^{1}/_{16}$ scale model of the Prototype Fast Reactor and the instrumentation used in measurements on the effect of an internal explosion on the reactor vessel are described. Outlines are presented for the analytical methods used to interpret: deflection of an edge fixed roof panel under dynamic pressure loading; response of a model structural roof to an impact pressure loading; and response of a full scale structural roof to an impact pressure loading. (H.D.R.)

28512 (EURFNR-626) LIQUID METAL BOILING RESEARCH. Peppler, W.; Schultheiss, G. F. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). Oct. 1968. 30p. (KFK-874; EUR-4157). Dep.

Work Performed under United States–Euratom Fast Reactor Exchange Program.

Experimental investigations of boiling phenomena for liquid metals carried out at Karlsruhe in a program to examine sodium-cooled fast reactor safety aspects are presented. Preliminary results of experiments on the influence of cavities and oxide concentration on sodium superheat and on boiling and recondensation phenomena in a large sodium loop are reported. 9 references. (H.D.R.)

28513 (IDO–17258) LOFT ENGINEERED SAFETY SYSTEMS INVESTIGATIONS. Dietz, K. A. (ed.) (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Apr. 1969. Contract AT(10-1)-205. 85p. Dep. CFSTI.

Two types of engineered safety systems, emergency core coolant systems and containment safety systems, are utilized to mitigate or arrest the consequences of a reactor loss-of-coolant accident. Phillips Petroleum Company has developed a program plan designated the LOFT Engineered Safety Systems Investigations program to provide verified analytical techniques that will strengthen the technical basis for the design and assessment of both types of engineered safety systems. The program consists of integrated analytical and experimental work. The experimental work consists of several programs designed to study the various processes occurring during the loss-of-coolant accident, either alone or in sequence. The experimental work culminates in a series of integral tests, during each of which the total sequence of the loss-of-coolant accident (including action of the engineered safety systems) is simulated in a small pressurized water reactor system. The objective of the LOFT-ESS program is to assure that the design and safety assessment of engineered safety systems can be made on a sound technical basis with a high level of confidence. In the initial section of the program summary, the sequence of the loss-of-coolant accident and the major processes are described in considerable detail. This description forms the framework for a detailed presentation of the status and future requirements for information, both analytical and experimental, necessary to achieve the overall objective of the LOFT-ESS program. A summary of the program rationale is presented, including the method of attacking the problem as well as the interrelationship among the various programs that make up the total LOFT-ESS effort. The detailed implementation of the total program is given in Parts A through K, which are technical descriptions of the individual smaller programs. (auth)

28514 (IDO–17258-A) REACTOR SYSTEMS RESPONSE ANALYTICAL DEVELOPMENT PROGRAM. Anderson, J. E.; Ybarrondo, L. J. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Apr. 1969. Contract AT(10-1)-205. 44p. Dep. CFSTI.

The analytical program for predicting and evaluating the response of water-cooled reactor systems to a loss-of-coolant accident is divided into three major mass and energy redistribution processes: (1) Primary coolant system thermal and hydraulic response; (2) Primary system structural response; and (3) Containment atmosphere thermodynamic response resulting from primary system decompression. Analytical model development tasks are identified, and the specific solution approaches to be followed in model development are discussed. (H.D.R.)

28515 (IDO–17258-B) FISSION PRODUCT BEHAVIOR ANALYTICAL DEVELOPMENT PROGRAM. Walker, D. H. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Apr. 1969. Contract AT(10-1)-205. 25p. Dep. CFSTI.

The LOFT program for identifying or developing analytical models to describe fission product behavior and for identifying and planning experiments to test the capabilities and limitations of these models is discussed. The output from the program will be analytical models whose capabilities and limitations have been tested by experiment. The models are needed for assessment of the radiological hazards which could result from a loss-of-coolant accident in a pressurized water nuclear reactor plant. More specifically, models are needed to predict the magnitude of fission product release to the containment atmosphere and to predict the subsequent rates for fission product deposition in the containment under natural response conditions (no containment safety systems), for the active fission product removal from the containment atmosphere by containment safety systems, and for the fission product leakage to the environment. (auth)

28516 (IDO–17258-C) SEMISCALE BLOWDOWN AND ECC. Curet, H. D.; House, R. K. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Apr. 1969. Contract AT(10-1)-205. 49p. Dep. CFSTI.

The blowdown and emergency core cooling studies, also referred to as the Semiscale Blowdown Program, compose an experimental program to investigate the hydraulic, thermodynamic, and mechanical behavior of a pressurized water reactor system during a loss-of-coolant accident. The investigations are being conducted in simulated reactor systems one-tenth the linear dimensions of a 1000 MW(e) commercial pressurized water reactor. Core heat addition is simulated electrically and engineered safety systems, such as emergency core cooling injection, are incorporated in the model systems. The objectives and status of the program are summarized. (auth)

28517 (IDO–17258-D) SCOPING EMERGENCY COOLING HEAT TRANSFER (SECHT) TESTS PROJECT. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Apr. 1969. Contract AT(10-1)-205. 22p. Dep. CFSTI.

The SECHT Tests Project consists of four series of scoping experimental investigations into emergency core cooling phenomena in which electrically heated rods are used to simulate nuclear fuel elements. Rods having radial dimensions approximately equal to those of commercial power plant fuel elements, but of shorter length, are assembled into small-scale arrays for the tests. The project also includes heater rod development and evaluation. The SECHT testing program objectives and accomplishments are summarized. (auth)

28518 (IDO–17258-E) PRESSURIZED WATER REACTOR: FULL-LENGTH EMERGENCY COOLING HEAT TRANSFER (PWR-FLECHT) TESTS PROJECT. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Apr. 1969. Contract AT(10-1)-205. 15p. Dep. CFSTI.

PWR-FLECHT is an experimental program to investigate the thermal response of PWR fuel to the injection of emergency core coolant following a loss-of-coolant accident. The tests are being conducted with full-size, electrically heated, simulated fuel pins in 49- and 100-rod arrays. The objectives of the FLECHT-PWR project are: (a) to provide experimental data for development of a one-dimensional core thermal response model for emergency core coolant injection, (b) to develop empirical ECC correlations for general use in calculating ECC's performance, and (c) to provide early ECC demonstration tests on Zircaloy cladding. (auth)

28519 (IDO–17258-F) FUEL HEATUP SIMULATION TESTS: FHUST. Curet, H. D.; Davis, P. R.; House, R. K.; Jensen, R. T.; McGrath, T. J. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Apr. 1969. Contract AT(10-1)-205. 38p. Dep. CFSTI.

The FHUST program is a portion of the separate effects activities under LOFT supporting development. The FHUST program is an experimental program to investigate the thermodynamic and mechanical behavior of pressurized-water-reactor fuel pins under simulated loss-of-coolant accident conditions with and without emergency core coolant injection. The major portion of the program consists of core heatup studies to determine the core heat transfer behavior before ECC injection; the remaining portion of the program consists of tests to determine the capability of ECC injection to terminate the core temperature transient for design and degraded ECC system operation. The investigations are being conducted using test configurations having from 9 to 232 pins, both with and without simulation of internal structures such as control rods, fuel element canisters, and support structures. Electrical heating is used in all experiments to model the decay heat and stored energy of standard reactor fuel pins. The FHUST program accomplishments and projected activities are summarized. (auth)

28520 (IDO–17258-G) LOFT INSTRUMENT DEVELOPMENT SUPPORT PROGRAM. Klingler, W. B. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Apr. 1969. Contract AT(10-1)-205. 21p. Dep. CFSTI.

The LOFT Instrument Development Support Program was established to provide the verified measurement capability required to meet the experimental measurement requirements of the LOFT integral tests and the LOFT small-scale separate effects tests. Since the acquisition of experimental information concerning the thermal, hydraulic, and mechanical processes in a loss-of-coolant accident is the principal objective of these tests, they can be conducted successfully only if adequate measurement capability is available. The experimental measurement requirements for the LOFT integral tests are given in IDO-17258 K. Instrumentation development is limited to those measurements which cannot be provided by commercially available instrument systems. The development is directed toward the detection device (transducer) and connecting cables. Commercially available signal conditioners are to be utilized where possible. (auth)

28521 (IDO–17258-H) CAROLINAS VIRGINIA TUBE REACTOR (CVTR) IN-PLANT TESTING PROJECT. Norberg, J. A. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Apr. 1969. Contract AT(10-1)-205. 35p. Dep. CFSTI.

The CVTR In-Plant Testing Project is being performed in the

CVTR facility at Parr, South Carolina. This project is to provide realistic information on containment system behavior that can be used to evaluate and improve analytical and experimental techniques, thus allowing increased confidence in applying such techniques to safety analysis of nuclear power plants. The primary objectives of this project are: (a) to obtain data on the pressure-temperature response of the CVTR containment system to simulated design basis accident (DBA) conditions and to compare these data with response predictions obtained through use of current analytical techniques, (b) to assess the effectiveness of a containment pressure reduction spray system, (c) to determine structural dynamic vibrational properties for comparison with predictions acquired from state-of-the-art seismic analyses, and (d) to evaluate procedures, instrumentation, and assumptions commonly utilized in leakage rate testing of power reactor containments. Secondary objectives of the program are: to measure the containment leakage rate as a function of pressure and temperature and to evaluate the effect of DBA conditions on leakage rate, vessel strain, and engineered safety system operation. (auth)

28522 (IDO-17258-I) FISSION PRODUCT SAMPLING AND DECONTAMINATION DEVELOPMENT PROGRAM. Schultz, R. J.; Walker, D. H. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Apr. 1969. Contract AT(10-1)-205. 38p. Dep. CFSTI.

The principal task of this program is the development and testing of techniques for obtaining and analyzing fission product samples during the LOFT test series. Coatings for protecting the concrete missile shield of the LOFT containment vessel from penetration by steam and fission products are also to be developed and tested. In addition, Idaho Nuclear Corporation is to develop and specify methods of decontaminating the containment following the LOFT nuclear tests. The principal facility utilized in this program is the Contamination-Decontamination Experiment (CDE) facility. The CDE facility is basically an 86 ft^3 tank used to represent a containment vessel. The tank is in a hot cell so that highly radioactive fission products can be employed. The fission products are introduced into simulated accident environments to provide samples for developing and testing analytical techniques and to contaminate samples for decontamination studies. The Fission Product Sampling and Decontamination Development Program has been divided into four areas of study: (a) fission product sampler development, (b) sample analysis and handling techniques, (c) protective coatings and (d) decontamination techniques. (auth)

28523 (IDO-17258-J) ORNL-LOFT FISSION PRODUCT SUPPORT PROGRAM. Matheney, G. B.; Parker, G. W.; Walker, D. H. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Apr. 1969. Contract AT(10-1)-205. 34p. Dep. CFSTI.

The major experimental areas in this program and the uses of the experimental data are: (1) Fission product buildup in the fuel pin plenum during reactor operation; (2) Fission product release upon cladding failure; (3) Fission product transport through the reactor system to the containment; and (4) Time-dependent fission product depletion and changes in the chemical state of radioiodine in the containment atmosphere and the effect of engineered containment safety systems on these processes. Fission product buildup in the fuel pin plenum will be studied in the laboratory with equipment constructed specifically for this purpose. Fission product release on cladding rupture, fission product transport to the containment, and fission product distribution in the containment will be studied in the Containment Research Installation (CRI) facility. (auth)

28524 (IDO-17258-K) LOFT INTEGRAL TEST PROGRAM. Dugone, J.; Solberg, D. E.; Walker, D. H. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Apr. 1969. Contract AT(10-1)-205. 119p. Dep. CFSTI.

The LOFT Integral Test Program to be performed with the Loss-of-Fluid Test (LOFT) Facility consists of a series of loss-of-coolant tests, in which the emergency core cooling system is operated both at design and degraded performance conditions. Other engineered safety systems, such as the containment pressure reduction spray system and the containment filter system, also will be operated and tested. The general objectives of the LOFT Integral Test Program are: (1) To verify the capability of analytical methods to predict the loss-of-coolant accident response of large power reactors, the performance of engineered safety systems, and the margins of safety inherent in their performance; and (2) To identify any unexpected events or thresholds not presently accounted for in the analysis of plant response or in the design of engineered safety systems. (auth)

28525 FLOATING PLANTS FOR SEISMIC PROTECTION. Busey, Harold M. (McDonnell Douglas Corp., Richland, Wash.). Nucl. Appl., 6: 533-43(June 1969).

The feasibility and safety of floating entire nuclear power plants on water to minimize stresses and differential deflections resulting from seismic shock are examined. Floating all components on a captive barge would permit plants to be located offshore, in bays or in rivers, near populated load centers. Various concepts are considered. Economic and safety considerations are examined for a 1000 MW(e) station utilizing a pressurized water reactor based on the Indian Point Nuclear Generating Unit No. 2. To permit comparison between the floating barge and other earthquake-protection methods, the design site was selected in the shallow water 2750 feet offshore near Los Angeles, California, where the Bolsa Island nuclear plant was being considered. (H.D.R.)

28526 TRITIUM IN POWER REACTORS. Ray, Joseph W. (Battelle Memorial Inst., Columbus, Ohio). Reactor Fuel-Process. Technol., 12: No. 1, 19-26(Winter 1968-69).

The potential radiological health hazard from tritium exposure is discussed, and maximum permissible concentration standards are tabulated. The principal means by which tritium is generated in light water reactors are reviewed. Tritium migration in the reactor system and release during fuel reprocessing are examined, and control and disposal methods are outlined. (H.D.R.)

28527 RELIABILITY TECHNIQUES AS APPLIED TO OPERATING SYSTEMS AND TO DESIGN OPTIMIZATION. Saltarelli, E. A.; Fitzgerald, D. G. (NUS Corp., Rockville, Md.). Reactor Fuel-Process. Technol., 12: No. 1, 55-65(Winter 1968-69).

A review of reliability techniques for reactor design safety is presented. A comparison of quantitative analysis techniques and qualitative analysis techniques is included. Comparative reliability analysis and sensitivity analysis techniques are described. The effects of testing frequency on system reliability of redundant configurations are discussed. 16 references. (D.C.C.)

28528 RADIOLYTIC DECOMPOSITION OF WATER IN WATER-MODERATED REACTORS UNDER ACCIDENT CONDITIONS. Turner, Stanley E. (Southern Nuclear Engineering, Inc., Dunedin, Fla.). Reactor Fuel-Process. Technol., 12: No. 1, 66-79(Winter 1968-69).

The effects of accident conditions on radiolytic decomposition of H_2O in water-moderated reactors are described. Theoretical considerations of possible reactions, reaction rates, and required activation energies are presented. Experimental data for radiolytic decomposition of H_2O are included. Hydrogen generation rates in reactors under coolant loss conditions are analyzed. The effects of reactor type on H_2 production under coolant loss conditions are described. A brief analysis of chemical additive effects on radiolytic H_2 production is included. 16 references. (D.C.C.)

28529 STUDIES ON A 600 MWe INTEGRATED GAS TURBINE POWER PLANT (NGK). Schafstall, H.; Ermisch, K.; Fuerste, W. (Brown Boveri/Krupp, Mannheim, Ger.). pp EN.1/17.1-12 of Symposium on the Technology of Integrated Primary Circuits for Power Reactors, Proceedings, Paris, 20th-22nd May 1968. Paris, European Nuclear Energy Agency, 1968.
See CONF-680525.

The design parameters and flow diagrams for a 20 MW(e) helium-cooled reactor non-integrated gas turbine system and a 600 MW(e) helium-cooled reactor integrated gas turbine system are presented. The safety aspects of each system are compared. (D.C.C.)

28530 WRED, A SITING CODE TO ESTIMATE DOSE PROBABILITY DISTRIBUTION FROM MEASURED METEOROLOGY DATA. Cooper, R. E. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Contract AT(07-1)-1. Health Phys., 16: 735-8 (June 1969).

WRED is a reactor siting code designed to estimate probability distributions of whole body γ and thyroid doses using measured meteorological parameters as input data. Distribution analyses are performed as a function of downwind distance, activity release height, and wind direction. This statistical approach for γ dose estimates, employing thousands of sets of meteorology data, is made economically feasible by using two-dimensional tables of space distribution-attenuation integrals and interpolation techniques. Measured meteorological parameters are converted to atmospheric dispersion parameters according to techniques developed at Brookhaven National Laboratory, and space distribution-attenuation integrals are computed by techniques developed at the Savannah River Laboratory. When utilizing the full capacity of the code, approximately 2000 sets of data (involving 16,000 each γ and thyroid dose calculations from raw meteorological data) are processed per minute on the IBM System 360/65. Concurrently, meteorological statistics are compiled, and all data are summarized for output. Provision is made for including compiled statistics from previous data processing to update the distribution analyses for each job. Code options allow minimum data input (wind speed, direction, temperature) or full input, including measured standard deviations of the horizontal and vertical wind directions. (auth) (UK)

28531 SAFETY CONSIDERATIONS OF INTEGRATED CIRCUITS FOR REACTOR PRIMARY SYSTEMS. Kaplan, S. I. (Oak Ridge National Lab., Tenn.). pp EN.1/44.1-9 of Symposium on the Technology of Integrated Primary Circuits for Power Reactors, Proceedings, Paris, 20th-22nd May 1968. Paris, European Nuclear Energy Agency, 1968.
See CONF-680525.

Safety aspects relating to the design of integrated gas-cooled power reactors are discussed. A review of research activities is presented. 9 references. (D.C.C.)

28532 RECOMMENDATIONS FOR THE DESIGN AND CALCULATIONS FOR REACTOR CONTAINMENT STRUCTURES WITH A VIEW TO NUCLEAR SAFETY. Costes, Didier (CEA, Paris). pp EN.1/6.1-9 of Symposium on the Technology of Integrated Primary Circuits for Power Reactors, Proceedings, Paris, 20th-22nd May 1968. Paris, European Nuclear Energy Agency, 1968. (In French).
See CONF-680525.

Problems in using prestressed concrete pressure vessels in large power reactors are discussed. Construction requirements are summarized. Safety aspects of the reactor vessel are discussed in detail. Effects of normal and abnormal operating conditions on the reactor vessel are considered. Protection and inspection of the frame are discussed. Problems with primary circuit integration are outlined. (M.L.S.)

28533 AN ORIGINAL SOLUTION: CONTAINMENT STRUCTURE WITH HEATED WALLS. Courbon, J.; Merot, J. P. (Societe d'Etudes et d'Equipements d'Entreprises, Paris). pp EN.1/7.1-14 of Symposium on the Technology of Integrated Primary Circuits for Power Reactors, Proceedings, Paris, 20th-22nd May 1968. Paris, European Nuclear Energy Agency, 1968. (In French).
See CONF-680525.

The concept of a prestressed concrete vessel as a heated wall is detailed. The vessel for a boiling heavy water reactor is described; the economics of using heated walls is outlined. Research done on the heating of the walls and its effects on the concrete and water is summarized. The limits on using this heated wall concept are defined. (M.L.S.)

28534 PROBLEMS CONNECTED WITH CONTAINMENT STRUCTURES OF WATER- AND GAS-COOLED REACTORS. Bernaix, J.; Puyo, A.; Picaut, J. (Coyne and Bellier, Paris). pp EN.1/5.1-5 of Symposium on the Technology of Integrated Primary Circuits for Power Reactors, Proceedings, Paris, 20th-22nd May 1968. Paris, European Nuclear Energy Agency, 1968. (In French).
See CONF-680525.

Problem areas with containment structures are defined. Requirements for reinforcing steels are outlined. Reinforcing and protection of the structure are described. Results of mockup studies are summarized. (M.L.S.)

28535 BETHE-TAIT ACCIDENTS IN WEAKLY COUPLED REACTOR SYSTEMS. McAnally, James Larry. Lafayette, Ind., Purdue Univ., 1968. 179p.
Thesis.

A mathematical model was developed which describes the meltdown accident in a system containing two weakly coupled reactor cores. A numerical solution was obtained for this model. The execution of the numerical solution was carried out by means of a FORTRAN-IV computer program, EMCC. EMCC-Explosion in Multiple Cores Code will solve the coupled core, time lag, kinetic equations for either one or two cores. Reactivity input may be a fourth-order polynomial. A Bethe-Tait explosion option can be chosen for core 1, whether it is isolated or adjacent to another core. Also a Doppler feedback option is available for either core. A parametric analysis was made of Bethe-Tait accidents in idealized, fast, coupled core reactors. From the parametric analysis, a linear relationship was observed between the energy released in the driven core and the neutron coupling coefficients for neutrons arriving at the driven core from the exploding core. The perturbation and energy release in the driven core will only be a function of the fraction of the burst of neutrons from the exploding core intercepted by the driven core. Also, the exploding core is not affected by the power burst in the driven core. (Disser. Abstr.)

Power Conversion Systems

Refer also to abstract 28595.

28536 (EUR-4101, pp 125-42) EXPERIMENTAL AND THEORETICAL INVESTIGATIONS OF SODIUM-WATER REACTIONS IN TUBES. Dumm, K.; Mausbeck, H.; Schnitker, W. (Internationale Atomreaktorbau G.m.b.H., Bensberg (West Germany)).

The facility and equipment used to investigate Na-water reactions in single-wall Na-heated steam generators are described. Some results of tests on the reaction behavior and the analytical interpretation of the test results are presented. (H.D.R.)

28537 THE THERMODYNAMIC PROPERTIES OF HELIUM AS A WORKING MEDIUM FOR NUCLEAR POWER PLANT GAS TURBINES. Bammert, K. (Univ., Hanover). Kerntechnik, 11: 88-91(Feb. 1969). (In German and English).

Temperature and pressure calculations for helium turbines for gas cooled reactors are described; enthalpy-entropy diagrams are the range of temperatures and pressures relevant to gas turbines. End temperature equations are given. (M.L.S.)

28538 METHOD OF HEATING WORKING MEDIUM IN THE HEAT EXCHANGER OF A NUCLEAR REACTOR INSTALLATION. Kagi, J. (to Sulzer Brothers Ltd.). Canadian Patent 803,697. Jan. 7, 1969. Priority date Aug. 13, 1964, Switzerland.

An efficient method is described for the transfer of heat from the reactor coolant to the working medium in response to varying loads. The system involves counter current flow, a distributing device, feed valves and "pipe strings." The net result is an adjustment of reactor power as required by different loads on the turbine. The working medium is preheated, evaporated, and superheated in the heat exchanger. (F.S.A.)

28539 THE APPLICATION OF CO_2 TURBINES TO INTEGRATED GAS COOLED REACTORS. Schabert, H. P. (Siemens Aktiengesellschaft, Erlangen, Ger.). pp EN.1/48.1-10 of Symposium on the Technology of Integrated Primary Circuits for Power Reactors, Proceedings, Paris, 20th-22nd May 1968. Paris, European Nuclear Energy Agency, 1968.
See CONF-680525.

Design characteristics of heavy water-moderated CO_2-cooled fast breeder power reactors are described. Direct and indirect CO_2 turbine cycles are compared. (4 references) (D.C.C.)

28540 STUDY OF AN INTEGRAL CARBON DIOXIDE-COOLED HEAVY WATER REACTOR. Fonteray, J.; Martin, R.; Roche, R. (CEA, Saclay, France). pp EN.1/4.1-11 of Symposium on the Technology of Integrated Primary Circuits for Power Reactors, Proceedings, Paris, 20th-22nd May 1968. Paris, European Nuclear Energy Agency, 1968. (In French).
See CONF-680525.

The advantages of integrating a primary circuit in carbon dioxide cooled reactors are summarized. The types and methods of design and construction of the integrated circuits are outlined. Problems in using an integrated circuit design are listed and discussed. (M.L.S.)

28541 INTEGRATED GAS TURBINE PLANTS USING CO_2 COOLED REACTORS. Kronberger, H. (United Kingdom Atomic Energy Authority, Risley, Eng.); Maillet, E.; Coast, G. pp EN.1/45.1-13 of Symposium on the Technology of Integrated Primary Circuits for Power Reactors, Proceedings, Paris, 20th-22nd May 1968. Paris, European Nuclear Energy Agency, 1968.
See CONF-680525.

Power cycles for CO_2-cooled power reactors are illustrated. Flow diagrams and illustrations are presented for a CO_2-cooled reactor with a reheat gas turbine system. (D.C.C.)

28542 POSSIBILITY OF THE OPERATION OF A NUCLEAR POWER PLANT WITH A GAS TURBINE UNDER OPTIMUM SAFETY AND ECONOMIC CONDITIONS. Foerster, S.; Heil, J.; Haarmann, W.; Krausen, Th.; Schneider, K. U. (Kernforschungsanlage, Juelich, Ger.). pp EN.1/11.1-14 of Symposium on the Technology of Integrated Primary Circuits for Power Reactors, Proceedings, Paris, 20th-22nd May 1968. Paris, European Nuclear Energy Agency, 1968. (In French).
See CONF-680525.

Use of high temperature gas cooled reactors and turbines for nuclear power plants is discussed. Cycle thermodynamics is considered; effects of turbine parameter variations on electrical generation costs are shown graphically. The construction of plants with integrated and non-integrated circuits is described; some examples of both types of circuits are shown. The use of prestressed concrete reactor vessels is considered. (M.L.S.)

28543 INTEGRATED NUCLEAR GAS TURBINES. Hurst, J. N.; Mottram, A. W. T. (Rolls-Royce Ltd., Derby, Eng.). pp EN.1/41.1-9 of Symposium on the Technology of Integrated Primary Circuits for Power Reactors, Proceedings, Paris, 20th-22nd May 1968. Paris, European Nuclear Energy Agency, 1968.
See CONF-680525.

Special problems are discussed, relating to design, cost, operation, maintenance and safety of helium gas turbines in integrated gas-cooled power reactors. (auth)

28544 DIRECT CYCLE APPLICATIONS OF HIGH TEMPERATURE GAS COOLED REACTORS. Shepherd, L. R.; Lockett, G. B. (Atomic Energy Establishment, Winfrith, Eng.). pp EN.1/40.1-16 of Symposium on the Technology of Integrated Primary Circuits for Power Reactors, Proceedings, Paris, 20th–22nd May 1968. Paris, European Nuclear Energy Agency, 1968. See CONF-680525.

Operating experiences with the Dragon Reactor are described. The current status of high-temperature gas-cooled reactor technology as it pertains to gas turbine application is considered. Design solutions for gas turbine systems are discussed for various configurations. (D.C.C.)

28545 HEAT EXCHANGERS AND TURBO MACHINERY FOR A NUCLEAR POWER PLANT WITH TWO 600 MW(e) CO_2 CLOSED CYCLES. Frieder, A. (Sulzer Freres, Winterthur, Switzerland); Kaegi, J.; Bischoff, R. pp EN.1/47.1-27 of Symposium on the Technology of Integrated Primary Circuits for Power Reactors, Proceedings, Paris, 20th–22nd May 1968. Paris, European Nuclear Energy Agency, 1968. (In French). See CONF-680525.

Reasons for the choice of carbon dioxide as a coolant for a high temperature gas cooled nuclear power plant are outlined. Heat exchanger design concepts and requirements are described. Design concepts for carbon dioxide turbomachinery are discussed; design parameters are tabulated. Thermodynamic calculations for the heat exchangers and reheaters are described; data are presented graphically and tabularly. (M.L.S.)

28546 HELIUM TURBINES FOR NUCLEAR POWER STATIONS. Bruett, Peter (Gutehoffnungshuette Sterkrade A G, Oberhausen, Ger.). Umsch. Wiss. Tech., 69: 149(Feb. 27, 1969). (In German).

The potential efficiency advantages for use of direct cycle helium turbines with high temperature gas-cooled power reactors are briefly discussed. (H.D.R.)

Research and Test Reactors

Refer also to abstracts 26603, 26628, 27143, 28270, 28301, 28423, and 28629.

28547 (ANL-7477) DEVELOPMENTS IN THE ELIMINATION OF BORON LOSS FROM UO_2–STAINLESS STEEL DISPERSION FUEL PLATES FOR THE ARGONNE ADVANCED RESEARCH MARK I CORE. Pearson, C. Victor (Argonne National Lab., Ill.). Oct. 1968. Contract W-31-109-eng-38. 67p. Dep. CFSTI.

Fabrication of the Type 347 stainless steel-clad stainless steel–UO_2 cermet fuel and Ni-coated ZrB_2 particle burnable poison is described for the Mark 1 core of the Argonne Advanced Research Reactor. Irradiation testing results are presented. 27 references. (D.C.C.)

28548 (BNL-12542) STAINLESS STEEL PRIMARY PIPING FOR THE HIGH FLUX BEAM REACTOR. Baldwin, Robert (Brookhaven National Lab., Upton, N. Y.). [1968]. 19p. (CONF-681209-1). Dep. CFSTI.

From Winter Annual Meeting of the American Society of Mechanical Engineers, New York.

Stainless steel piping is now being used more for a variety of process systems. In many ways the stainless steel piping for the High Flux Beam Reactor (HFBR) is typical of these piping systems. The HFBR stainless steel piping system is discussed with respect to design, materials, fabrication, inspection, testing, and modifications installed after operation of the system. 8 references. (auth)

28549 (BNWL-957) INSTRUMENTATION FOR ANALYSIS OF THE INERT GASES USED IN FFTF. Barton, G. B. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 1969. Contract AT(45-1)-1830. 56p. Dep. CFSTI.

Inert gas monitoring needs of the FFTF are reviewed. The selection criteria for the required instrumentation is defined. Current technology and commercially available on-line gas analytical instrumentation are reviewed and compared to FFTF requirements. Results conclude that FFTF cell blanket gas analytical needs can be met in almost all instances by commercially available instrumentation. Current technology is inadequate to meet Na cover gas monitoring needs and a development effort is required. Gas chromatography and possibly mass spectrometry appear to hold the greatest promise of meeting Na cover gas monitoring needs. 11 references. (auth)

28550 (BNWL-973) SURVEY OF CONTROL ROD DRIVE MECHANISMS FOR APPLICATION TO THE FFTF. Noakes, J. C.; Telford, P. K. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Feb. 1969. Contract AT(45-1)-1830. 90p. Dep. CFSTI.

A state-of-technology survey was completed on candidate control rod drive mechanisms (CRDM) for the Fast Test Reactor (FTR). Drive mechanisms reviewed include proven designs used in liquid metal cooled reactor systems, designs developed and tested for Na cooled reactor systems, proven designs used in water cooled thermal reactor systems, and conceptual designs emphasizing basic simplicity. Even though each of these control rod drive mechanisms was designed for a specific set of requirements, it is concluded that the CRDM concepts surveyed provide a valid basis for selection of specific concepts to be designed and developed to provide safe and efficient nuclear control of the FTR. 67 references. (auth)

28551 (DOCKET-50148-1) [UNIVERSITY OF KANSAS RESEARCH REACTOR]. Amendment to License No. R-78. (Kansas Univ., Lawrence). July 6, 1967. 3p. Dep. CFSTI.

The lithium fluoride (LiF) personnel dosimeter (TLD) proposed to replace the commercial film badge service at the University of Kansas Research Reactor, is described. Average yearly personnel exposures are given. The annealing procedures, calibration techniques, and significant characteristics of the TLD are included. (M.L.S.)

28552 (EIR-148) DECONTAMINATION OF THE ROD CHANGE ZONE AND REMOVAL OF THE EXHAUST FILTER AFTER A URANIUM ROD FAILURE IN DIORIT. Suter, F. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen (Switzerland)). Jan. 1969. 29p. (In German). Dep.

As a result of a cladding failure on a U rod, the rod change zone after the rod exchange, the air conditioning system between exchange surface and filter group, and the filter group itself were strongly contaminated. The course of the incident and the radiation conditions are described. The dismantling of the rod exchange area and the exchange of the exhaust filter are described. The personnel doses and the work and material expenditure during the decontamination operation are evaluated. (J.S.R.)

28553 (EUR-4101, pp 345-77) FULL SCALE EXPERIMENT ON THE CONSEQUENCES OF A PRESSURE TUBE RUPTURE IN ESSOR REACTOR VESSEL. Holtbecker, H.; Montagnani, M.; Verzeletti, G. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center).

Characteristics of the test rig used in full scale simulation of the failure of an ORGEL channel are described. Results are presented and analyzed for: effects of the pressure wave produced by a burst channel; pressure transients due to vaporization and fast condensation of moderator; static loading of the vessel; and temperature rise in channels affected by the organic jet. 4 references. (H.D.R.)

28554 (EUR-4101, pp 393-410) SIMULATION OF EXPLOSIVE ACCIDENTS IN A FAST REACTOR. Falgayrettes, M.; Millot, J. P. (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). (In French).

The fast sodium-cooled reactor RAPSODIE is briefly described. Equipment and instrumentation are described and results are discussed for a series of $^3/_{10}$ and $^1/_{10}$ scale model tests on the effects of internal explosions on the reactor structures. (H.D.R.)

28555 (IFA-TR-56) THERMAL NEUTRON FIELD PULSING, TEMPERATURE OF COOLANT CHANNEL WALLS AND WATER LEVEL OF SEPARATE VERTICAL CHAMBER DURING BOILING IN ACTIVE ZONE OF WWR-S REACTOR. Dzhordzhesku, R.; Dobresku, K. (Academia R. P. R., Bucharest. Institutul de Fizica Atomica). 1968. 25p. (In Rumanian). Dep.

Analysis of the pulsations of the various parameters is a sensitive method for identifying the processes involved in boiling. In view of the fact that earlier studies considered only the pulsation of the thermal neutron field, caused by changes in the moderator, experiments were carried out to examine the importance of other factors. The experimental chamber was placed in the core of the WWR-S reactor, replacing one of the fuel-element assemblies. The reactor was operated at a constant power level of 5 kW during the experiment. Pulsations of the thermal-neutron field measured by means of an ionization chamber placed 200 mm from the edge of the core, studying them by a frequency analyzer within the 0.1 to 40 Hz range. The chamber consisted of an Al pipe, heated by a tube to which a Nichrome wire was attached. The temperature of the pipe wall, heater wall and the water at various heights was measured by Cu-constantan thermocouples with an error of less than 0.25°C; a float attached to a potentiometer was used to determine the water level. From the harmonic distribution of the various pulsations, the frequency dependence of the relative amplitudes was derived. The analysis indicated resonance regions at 0.1 and 20 Hz. The 0.1 Hz pulsations were attributed to variations of the amount of steam in the system; the second resonance region was assumed to reflect the process of formation and rise of the bubbles on the heater wall. The temperature jumps resulting from the regeneration of the superheated layer were held responsible for the temperature pulsations of the heater wall. 17 references. (TTT)

28556 (JUL-555-RE) RADIATION PROTECTION EXPERIMENTS AT THE CONSTRUCTION OF THE RESEARCH REACTOR FRJ-1 (MERLIN). Jahn, H.; Laumen, K. J. (Kernforschungsanlage, Juelich (West Germany). Zentralabteilung Forschungsreaktoren). Nov. 1968. 31p. (In German). Dep.

In order to improve the experimental facilities at the research reactor FRJ-1, reconstruction work was carried out in the reactor tank. This work was done after the reactor had been in operation for several years and the building components, especially those of the inside of the tank had been highly activated. For the protection of the construction personnel, comprehensive safety precautions were necessary. The dose output, contamination, and air activity measurements made before the start of the reconstruction for evaluation of the radiation protection needed are reported. The protective measures during the reconstruction are given. It was shown that safer power operation of the reactor is probable after the reconstruction. 6 references. (tr-auth)

28557 (KURRI-TR-16) INITIAL TESTING OF THE KUR. Shibata, Shunichie; (and others) (Kyoto Univ. (Japan). Research Reactor Inst.). [nd]. 161p. (In Japanese). Dep.

The KUR is a 90% enriched U-fueled, BSR-type 1,000 kW reactor, contained in a 2-m diameter, 8-m high Al tank to facilitate core cooling and to provide intense neutron beams for research purposes. The first critical test was made on June 25, 1964. The various tests that were conducted with this reactor, starting from the first critical experiment through a year of subsequent study, are compiled. The subjects include the overall description of the KUR, critical experiment, control rod calibration, reactivity measurement, determination of thermal neutron flux distribution in core and output calibration, determination of the temperature coefficient, testing of the cooling system, neutron flux for the research facility and γ dose rate measurement, radioactivity in the primary coolant, experiments with heavy water, and testing of the reactor container. (TTT)

28558 (KURRI-TR-44) RADIOACTIVE GASES GENERATED DURING THE OPERATION OF THE KUR. Tsujimoto, Tadashi; (and others) (Kyoto Univ. (Japan). Research Reactor Inst.). Dec. 26, 1967. 16p. (In Japanese). Dep.

The atmosphere around an experimental reactor such as the KUR becomes contaminated by radioactive dust and gas during reactor operation. A study was made to determine how to minimize the release of radioactive gas to the atmosphere during operation of the KUR by varying the operating conditions. The results showed that the radioactive gas diffused out through the outlet of the reactor tank of the primary purification system, top shield, and the experimental ports. The amount of radioactive gas generated was affected by the water temperature of the primary cooling and the rate of air change within the reactor chamber. The changes were observed by following mainly the concentration changes of ^{41}Ar. It was concluded that the results of this study make it possible to devise a scheme to control the release of radioactive gases. (TTT)

28559 (LA-4037) OPERATING PROCEDURES FOR THE PAJARITO SITE CRITICAL ASSEMBLY FACILITY. Koontz, P. G.; Orndoff, J. D.; Paxton, H. C. (Los Alamos Scientific Lab., N. Mex.). Oct. 1, 1968. Contract W-7405-eng-36. 11p. Dep. CFSTI.

Procedures for the safety plans of the Los Alamos Critical Assembly Facility are described. (D.C.C.)

28560 (MIT-1967-2) RESEARCH AND EDUCATIONAL ACTIVITIES AT THE MIT RESEARCH REACTOR, FISCAL YEAR 1968. (Massachusetts Inst. of Tech., Cambridge. Dept. of Nuclear Engineering). Dec. 1968. Contract AT(30-1)-1967. 143p. (MITNE-98). Dep. CFSTI.

The research and educational activities which utilized the Massachusetts Institute of Technology, five-megawatt, heavy water, research reactor during fiscal year 1968 are described. Research projects at MIT which make significant use of the MITR are described, and principal participating personnel are named. Listings are provided of theses, reports, journal articles, and conference papers resulting from these projects during fiscal year 1968. In addition to the educational value derived from the many research activities by the students who participated in them, training in several areas of nuclear technology is imparted through formal courses designed to make use of the reactor or its research projects. The courses are briefly described, and attendance figures are given. The reactor, its purpose, its organization, and a summary of operations are briefly described in order to provide a more complete understanding of the MITR program. 32 references. (auth)

28561 (NP-17819) ANNUAL SCIENTIFIC REPORT, 1966. Billiau, R.; Buyse, L.; Fredrix, H. (eds.) (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)). 147p. (D-79/67). Dep.

Separate abstracts were prepared for six sections of this report. Other sections deal with general services and administration. Seven appendixes are included containing lists of publications, colloquiums, theses, bibliographies, patents, conferences, and scientific films. (E.R.B.)

For abstracts of individual sections see: 26267, 26686, 26770, 27694, 28300, and 28562.

28562 (NP-17819, Chap.1) TECHNOLOGICAL RESEARCH-REACTORS AND FUEL CYCLE. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)). 43p.

Operations for the BR-2 and BR-3 reactors are described. Development programs for fast reactors are reviewed. Results of the VENUS critical experiment are presented. The fabrication and testing programs for PuO_2-UO_2 thermal reactor fuel are described. (D.C.C.)

28563 (ORNL-tr-1131) MESPRO 64: THE OPERATING SYSTEM FOR THE INTEGRATED COMPUTER INSTALLATION MIDAS. Krueger, G.; Zipf, G. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Kernphysik). Translated for Oak Ridge National Lab., Tenn., from report KFK-371. 59p. Dep. CFSTI.

The MIDAS data acquisition and processing system for the FR-2 reactor is described. The principles of the MESPRO 64 program construction are presented. The time schedules and program sequences are discussed. (D.C.C.)

28564 EXCHANGE OF NOTES BETWEEN THE GOVERNMENT OF THE UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND AND THE GOVERNMENT OF THE SOCIALIST REPUBLIC OF RUMANIA CONCERNING THE SUPPLY OF CERTAIN NUCLEAR RESEARCH MATERIAL AND EQUIPMENT TO RUMANIA. Treaty Series No. 33 (1969). London, Her Majesty's Stationery Office, 1969. 4p. 9d.

Reference is made to a provisional contract with Fairey Engineering Ltd of UK to supply nuclear research material and equipment to Rumania, including the following items: A "Helen" subcritical assembly, together with 2 tonnes of natural uranium fuel; a stack of nuclear grade graphite for experimental purposes, the amount of graphite required being 70 tons; 450 grams of 80% enriched uranium; also, if required, a further 7 tonnes of natural uranium fuel, on sale or hire. The supply will be for peaceful purposes only, and subject to the safeguards of the IAEA. (UK)

28565 UTILIZATION OF PERT FOR PROGRAMMING THE DESIGN AND CONSTRUCTION OF A RESEARCH REACTOR. di Bartolo, G. F.; Musso, B.; Zona, R. Ing. Nucl., 9: No. 6, 13-17(Nov.-Dec. 1968). (In Italian).

Use of the PERT system for control of design and construction of the TAPIRO fast research reactor of the Italian CNEN is discussed. Scope and characteristics of the work are described. Criteria for the program are given; a flow sheet for execution of the ideal work program is included. (M.L.S.)

28566 TEST-REACTOR PERSPECTIVES. Lane, James A. (Oak Ridge National Lab., Tenn.). Reactor Fuel-Process. Technol., 12: No. 1, 1-9(Winter 1968-69).

A review of the historical evolution of research and test reactors during the last two decades indicates a distinct trend toward higher and higher neutron-flux levels despite associated increases in both investment and operating costs. It appears, however, that, for cross-section measurements, neutron-diffraction work, solid-state physics, and other nuclear research programs, the end point in test-reactor development has been reached. Other approaches such as pulsed-accelerator sources or improved measuring techniques offer more for such programs than higher reactor fluxes. On this basis the only justification for building a test reactor with fluxes above 10^{16} neutrons/(cm^2)(sec) is the investigation of the effect of fast-neutron bombardment on metals and other reactor materials at high fluences. Although a fast reactor is generally believed to be the best means of obtaining such data, the possibility also exists of using a high-power-density thermal high-flux reactor for fast-neutron damage experiments. It is the opinion of some experts in the field that this latter approach may provide more immediate answers to some of the problems confronting fast breeder development. (auth)

28567 METHODS FOR THE IRRADIATION OF STEEL SAMPLES AT THE FRG. Ahlf, J. pp 31-42 of Reaktordruckgefaess-Staehle und ihr Verhalten Unter Bestrahlung. Fischer, E.; Melkonian, G. A. (eds.). Muenchen, Verlag Karl Thiemig KG, 1968. (In German).

From Conference on Radiation Effects on Materials, Geesthacht, West Germany. See CONF-670336.

Capsule and loop irradiations carried out on notched bar samples are described. The temperature and neutron flux measurements are discussed. The irradiation devices are described in detail. An improved irradiation capsule was developed for notched bar and tensile samples. (J.S.R.)

28568 NUCLEAR REACTOR AS A PULSED NEUTRON SOURCE. van Dievoet, J. P.; Fossoul, E.; Stievenart, M.; Tavernier, G.; Herzog, G.; Hildenbrand, G.; Michael, H.; Schwarz, E. (to Siemens-Schuckertwerke Aktiegesellschaft). Canadian Patent 803,695. Jan. 7, 1969. Priority date Apr. 24, 1963, Germany.

A method is described of modulating a nuclear reactor by rotating two structures in mutually overlapping relation outside the fission region of the reactor, in front of a neutron window. Each structure is provided with mutually spaced portions of neutron-active substance in the area of overlap so as to pass the neutron window during rotation and arranging the portions in a regularly repetitive geometric pattern, whereby the reactor operation is caused to pulsate in accordance with a pulse wave shape with pulse repetition frequency depending upon the rotational speeds and the geometric patterns. The highly enriched fuel rods in the core are of varying lengths so that the overall shape of the core is approximately spherical. Other associated equipment is also described. (F.S.A.)

28569 SINGLE ROD FINE DISTRIBUTION OF THE FAST FISSION RATIO. Aiello, V.; Maracci, G.; Rustichelli, F. (CCR-EURATOM, Ispra, Italy). Nucl. Sci. Eng., 36: 441-4 (June 1969).

Measurements are described of the integral value of the fast fission ratio in single rods of natural U embedded in graphite in the RB-2 reactor. The fast fission ratio was measured by the integral γ-ray counting technique; experimental details are given. Experimental results are given; these are compared with other fast fission ratio and five distribution results. (11 references) (M.L.S.)

28570 HISTORY AND DEVELOPMENT OF FAST BURST REACTORS 1944–1965. Wood, David P. (Atomic Energy Commission, Washington, D. C.); O'Brien, Paul D.; Wimett, Thomas F. Nucl. News, 12: No. 4, 32-7(Apr. 1969).

Fast burst reactor development from the initial operation of the Dragon Experiment at Los Alamos is reviewed. Descriptions and modes of operation are presented for nine enriched uranium fueled and alloyed-uranium fueled fast burst reactors. (H.D.R.)

28571 DRAGON EXPERIMENT. Frisch, Otto (Univ. of Cambridge, Eng.). Nucl. News, 12: No. 4, 30-2(Apr. 1969).

The construction of the Dragon Experiment at Los Alamos in 1945 is described. Dragon consisted of an assembly of enriched uranium hydride bricks with a hole in the middle. The missing portion was allowed to drop through the assembly under such conditions that a short-lasting harmless fast fission reaction resulted. (H.D.R.)

28572 SURVEY OF SAFETY INSTRUMENTATION AND INTERLOCK REQUIREMENTS. Shon, Frederick J. (Atomic Energy Commission, Washington, D. C.). Nucl. News, 12: No. 4, 37-42(Apr. 1969).

Scram circuits and safety systems for fast burst reactors are described. Redundancy and coincidence logic requirements of the systems are examined, and single failure analysis of the circuits is discussed. (H.D.R.)

28573 SURVEY OF FAST BURST REACTOR OPERATING PROCEDURES. Long, Robert L. (Univ. of New Mexico, Albuquerque). Nucl. News, 12: No. 4, 42-7(Apr. 1969).

The common practices and the variations in practice for operation of six fast burst reactor facilities are reviewed. Operations manuals are examined with attention to: staffing; review and approval of experiments; radiological safety control; checkout and startup procedures; burst sequence procedures; maintenance; and emergency procedures. (H.D.R.)

28574 OPERATION AND DEVELOPMENT OF PERIODICALLY PULSED REACTORS. Anan'ev, V. D.; Blokhintsev, D. I.; Bunin, B. N.; (and others) (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. News, 12: No. 4, 47-52(Apr. 1969).

The operations history of the IBR pulsed reactor since 1960 is summarized. Main characteristics of the IBR-30, an improved version of IBR, and of boosters and electron injectors used at the facility are tabulated. Design parameters of the more advanced IBR-2, a repetitively pulsed fast liquid-metal-cooled reactor with an electron accelerator as injector, are discussed. (H.D.R.)

28575 PRESSURIZED FACILITY FOR HIGH-TEMPERATURE SUBCRITICAL EXPERIMENTS. Carver, J. G. (North American Rockwell Corp., Downey, Calif.). Nucl. Appl., 6: 526-32 (June 1969).

A pressurized subcritical facility was constructed with its main pressure vessel directly above a 28-inch (71-cm) diameter fission source plate centered on the top face of the General Electric Nuclear Test Reactor (NTR). The main pressure vessel had an inside diameter of 36 in. and inner length (less head) of 48 in. to accommodate light-water-moderated fuel lattices with a k_{eff} of ≤ 0.98, constructed of low-enrichment oxide fuel rods. Maximum operating conditions for the facility were 540°F at 1050 psig. The system was heated electrically at 110 kW to raise the temperature and at 35 kW to maintain it at 540°F. With the NTR at 30 kW, and with lattice k_{eff} of ~ 0.97, the fission source plate induced a thermal neutron flux of $\sim 6 \times 10^8$ n/(cm^2 sec) at lattice center. The facility has been used to carry out a program of measurements of nuclear reaction rates within H_2O-moderated subcritical lattices of plutonium-enriched oxide fuel rods. (auth)

Rocket and Space Reactors

Refer also to abstract 27133.

28576 (N–69-10067) NUCLEAR-ROCKET PROPULSION. Rom, Frank E. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Nov. 1968. 40p. (NASA-TM-X-1685). CFSTI.

The three basic types of nuclear rocket powerplants (solid, liquid, and gas core) are compared. Solid core systems are expected to have specific impulses of 850 seconds with negligible fuel loss. The liquid core nuclear rocket will have a U loss rate of 0.01 to 0.1 mass unit per mass unit of H if specific impulses in the range of 1200 to 1500 seconds are desired. The gas core system will have similar loss rates of U but will produce specific impulses in the range of 1500 to 2500 seconds. (auth) (STAR)

28577 (N–69-10099) URANIUM DIOXIDE VENT LOSS IN AN EXTERNALLY FUELED THERMIONIC REACTOR CONCEPT. Ward, James J.; Ruch, Robert B. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Nov. 1968. 21p. (NASA-TN-D-4922). CFSTI.

An analysis of fuel losses through a fission gas vent in a nuclear thermionic reactor concept is presented. The converters are externally fueled with ceramic UO_2, and fuel losses during both steady-state operation and temperature excursions are estimated. Calculations were performed for element fuel-volume fractions of 0.275 and 0.55 with converter heat fluxes of 50 and 100 W/cm^2 at an emitter temperature of 2000°K. The absolute UO_2 loss during a temperature excursion and the ratio of UO_2 loss during an excursion to the yearly steady-state loss are presented as functions of time for each case. (auth) (STAR)

28578 (N–69-10734) CALCULATION OF FUEL LOSS FROM VENTED NUCLEAR FUEL ELEMENTS FOR SPACE POWER REACTORS. Gluyas, Richard E. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Nov. 1968. 40p. (NASA-TN-D-4913). CFSTI.

The rate of loss of UO_2 or of UN from cylindrical nuclear fuel elements which are vented to prevent buildup of high fission gas pressures has been calculated for various conditions. For 10,000 hr operation at a cladding temperature of 1400°C and venting to a vacuum, the maximum fuel temperature allowable for UO_2 is about 2000°C and for UN about 1800°C. These temperatures may be increased to about 2500° and 2600°C, respectively, by venting to an Ar atmosphere containing enough O_2 or N_2 to prevent decomposition of the fuels. (auth) (STAR)

28579 (N–69-14503) TRANSFER FUNCTIONS FOR RADIATOR DYNAMICS IN THE SNAP-8 SYSTEM. Leko, Robert W.; Jefferies, Kent S. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Dec. 1967. 22p. (NASA-TN-D-4946). CFSTI.

An analytical study was conducted to determine approximate radiator transfer functions for use in SNAP-8 ground test facilities. Theoretical equations for transient heat transfer and flow processes in the radiator were programmed on a digital computer. With this computer simulation, the frequency response of the radiator-outlet temperature was determined. Approximate transfer functions were determined from the frequency-response information. The transfer function determined for outlet temperature to inlet temperature was a single lag of third order cascaded with a dead-time function. The time constant and dead time were inversely proportional to flow rate. The simplified transfer function chosen to describe the response of outlet temperature to inlet flow rate was a first-order lag. The first-order lag time constant was in inverse proportion to the flow rate. (auth) (STAR)

28580 (N-69-17313) A 1-MEGAWATT REACTOR DESIGN FOR BRAYTON-CYCLE SPACE POWER APPLICATION. PART 1. THERMAL ANALYSIS AND CORE DESIGN. Whitmarsh, Charles L. Jr.; Kerwin, Paul T. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Feb. 1969. 45p. (NASA-TN-D-5013). CFSTI.

Thermal-hydraulic calculations are presented for a 1-MW gas-cooled reactor designed to retain all fission gases and to operate for 25,000 hours with a coolant outlet temperature of 1650°K. These data are combined with neutronics data in an effort to minimize core size. Parameters investigated are fuel-element configuration, fuel-cladding temperature, radial and axial power distributions, coolant inlet temperature, coolant pressure, and reactor pressure drop. (auth) (STAR)

28581 (N-69-17314) A 1-MEGAWATT REACTOR DESIGN FOR BRAYTON-CYCLE SPACE POWER APPLICATION. PART 2. NEUTRONICS DESIGN. Whitmarsh, Charles L.; Kerwin, Paul T. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Feb. 1969. 33p. (NASA-TN-D-5014). CFSTI.

General characteristics are determined for a gas-cooled reactor designed to operate at 1 MW for 25,000 hours with a coolant outlet temperature of 1650°K. Design curves relating core size to fuel concentration are presented as a function of radial power flattening. (auth) (STAR)

28582 (ORNL-3902) MPRE FUEL ELEMENTS: MANUFACTURE, INSPECTION, DRAWINGS, AND SPECIFICATIONS. Tolson, G. M. (Oak Ridge National Lab., Tenn.). Jan. 1966. Contract W-7405-eng-26. 122p. Dep. CFSTI.

The Medium Power Reactor Experiment (MPRE) is a prototype of a boiling-potassium reactor in a single-loop nuclear power plant suitable for a variety of space missions. The fuel elements consist of highly enriched UO_2 pellets in Type 316H stainless steel tubular cladding. Beryllium oxide pellets above the UO_2 serve as a reflector and in conjunction with a gadolinium aluminate pellet provide a thermal-neutron shield to suppress activation of the upper regions of the reactor. The specifications, methods of manufacture and inspection of the components, and assembly and inspection of the finished fuel element are described. Appendices contain as-built drawings and specifications as well as vendor manufacturing and inspection procedures. (auth)

28583 (ORNL-TM-1344) FUEL ELEMENT DESIGN FOR BOILING POTASSIUM REACTORS. Samuels, G. (Oak Ridge National Lab., Tenn.). Jan. 1966. Contract W-7405-eng-26. 47p. Dep. CFSTI.

A parametric analysis was made of internal temperatures, pressures, and fission product activity in stainless steel-clad-UO_2-fuel elements with particular emphasis on the MPRE fuel element design. For the maximum power element in the MPRE, the central UO_2 temperature was calculated to be 2580°F, the fission gas release rate was 1.45%, and the equilibrium activity diffusing from the UO_2 was 2.9 curies per element. For a leaking element in which the helium and fission products within the capsule are replaced by potassium vapor, it may be necessary to reduce the reactor output to 70% of full power to prevent central UO_2 temperatures from exceeding 2900°F. (auth)

28584 (ORNL-TM-1368) CONTROL CONCEPTS AND DIGITAL COMPUTER ANALYSIS OF THE MPRE FLUID SYSTEM. LaVerne, M. E. (Oak Ridge National Lab., Tenn.). Feb. 1966. Contract W-7405-eng-26. 68p. Dep. CFSTI.

The basic MPRE single-loop boiling K Rankine cycle system is described. The operational parameters of the system are outlined. The various stability and control problems are analyzed. The digital computer analysis of the Rankine cycle system is summarized. (25 references) (D.C.C.)

28585 (ORNL-TM-1370) CONTROL CHARACTERISTICS OF RANKINE CYCLE SYSTEMS WHICH SIMULATE THE MPRE FLUID SYSTEM. Yarosh, M. M. (Oak Ridge National Lab., Tenn.). [1966]. Contract W-7405-eng-26. 78p. Dep. CFSTI.

In conjunction with the Medium Power Reactor Experiment Program at ORNL, studies were conducted on two single-loop Rankine cycle systems. These systems were controlled using the same design concept which has been proposed for control of the MPRE fluid system. Experiments were run with water and potassium test facilities which were reduced scale electrically heated mockups of the proposed reactor and power recovery system. Results from these studies demonstrate that with proper design, the distribution of liquid inventory within the system can be controlled by the degree of cavitation occurring in the turbine-driven centrifugal boiler feed pump. Boiler power changes were made over a wide range and no operator action was required. The changes in fluid flow requirements were accommodated by a variation in the degree of pump cavitation occurring. Step changes in power were imposed on the boiler and there was no indication of instabilities in the fluid system. (auth)

28586 (ORNL-TM-1371) ANALYSIS OF THE HOT SPOT PROBLEM IN THE MPRE. LaVerne, M. E. (Oak Ridge National Lab., Tenn.). Dec. 1966. Contract W-7405-eng-26. 22p. Dep. CFSTI.

An analysis of the flow distribution in MPRE-type rod bundles has been made in order to assess the extent to which nonuniform vapor generation affects the flows and thus the development of potential hot spots in such bundles. A computer program embodying the analysis has been written and tested. Results of computer runs indicate that the flow channel couplings characteristic of the MPRE-type core greatly diminish the effects of dissymmetry. (auth)

28587 (ORNL-TM-1494) AN ANALOG COMPUTER STUDY OF THE CONTROL CHARACTERISTICS OF THE MEDIUM POWER REACTOR EXPERIMENT SYSTEM INCLUDING THE TURBINE-GENERATOR. Burke, O. W.; Ditto, S. J.; Walker, C. S. (Oak Ridge National Lab., Tenn.). May 6, 1966. Contract W-7405-eng-26. 22p. Dep. CFSTI.

The stability and control characteristics of the medium Power Reactor Experiment (MPRE), including the turbine-generator unit and the reactor system, were investigated by means of an analog computer. The generator terminal voltage and frequency were controlled for two types of electrical loads. One load was entirely resistive and the other was similar to that imposed by induction motors driving pumps. Two control schemes were used. In Control Scheme No. 1, the generator terminal voltage-error signal was the input to a controller which regulated the reactor control-plug position, and the generator frequency-error signal was the input to a controller which regulated the generator field current. The controller input signals were interchanged for Scheme No. 2. The time lags for the system were found to be relatively short, the time constant for the boiler being about 12.5 sec. With a simple resistive load the system was found to be stable and controllable when using either control scheme; however, the response characteristics were much better for Scheme No. 1. With the simulated induction motor load, Scheme No. 2 gave acceptable results; however, the results for this load were not as good as those for the resistive load. Stable plant operation was not achieved when using Control Scheme No. 1 with the motor load. (auth)

28588 (ORNL-TM-1611) THEORETICAL INVESTIGATION OF THE DYNAMIC BEHAVIOR OF THE MEDIUM POWER REACTOR EXPERIMENT. Smith, O. L.; Robinson, J. C. (Oak Ridge National Lab., Tenn.). Jan. 1967. Contract W-7405-eng-26. 73p. Dep. CFSTI.

The transient behavior of the MPRE under a variety of non-equilibrium conditions is analyzed. A fairly generalized physical and mathematical model of the system is developed, including detailed descriptions of the neutronics and thermodynamics of the fuel, the two-phase flow in the boiler, and the single-phase flow in the remainder of the system. The characteristics of system components such as turbine and jet pumps are represented by empirical relations based on experimental data. Provision is made for arbitrary reactivity input to perturb the system. Reactivity feedback occurs through axial expansion of the fuel and radial expansion of the core support structure. Changes in coolant inventory in the boiler have a very small effect on the system reactivity and are neglected. A provision is made for scramming the reactor at a specified power level. The mathematical problem is solved numerically by a code written in FORTRAN II for the IBM 7090 computer and in FORTRAN IV for the IBM 360 computer. Several calculations are performed with the model to study the general behavior of the system under various transient conditions. The model is a first approximation to an accurate mock-up of the system and the known limitations of the model are noted. (auth)

28589 (ORNL-TM-1619) POSSIBLE CONTROL MECHANISMS FOR THE MPRE. Smith, O. L.; Robinson, J. C. (Oak Ridge National Lab., Tenn.). Jan. 1967. Contract W-7405-eng-26. 23p. Dep. CFSTI.

Three possible control devices for the MPRE are studied: an iris diaphragm of B_4C across one end of the reactor core; a set of rotating BeO drums inlaid with thin layers of B_4C in the side reflector; and a movable plug of reflector at the bottom of the core. The control devices are evaluated in terms of a reference reactor that is intended to approximate the design configuration of the

MPRE as nearly as possible at the present time. Current estimates indicate that a 4% reactivity swing may be necessary for total reactor control over a 3-year period. The iris diaphragm device can produce only about a 1.5% reactivity change, and it is therefore unsatisfactory for total reactor control. The rotating drums can produce up to a 15% change in reactivity, and the movable plug can produce at least a 5% change. Consequently the latter two mechanisms satisfy the requirement for at least a 4% reactivity swing. Furthermore the drums and plug are found to produce acceptable perturbations of the core power distribution over the operating ranges of the control devices. Of the estimated 4% reactivity swing required for total reactor control, about $1\frac{1}{2}\%$ is believed to be needed for high temperature operation. The rotating drums produce approximately a 10% change in power density over this range, while the movable plug produces approximately a 20% change. These are the changes that occur at the core surface; the changes inside the core are somewhat smaller. A heat transfer study shows that the discontinuities produced in the reflector by the drums do not lead to unacceptable temperature profiles in the reflector. (auth)

28590 (ORNL-TM-1620) SOME CALCULATIONS PERFORMED ON A SERIES OF CONCEPTUAL FAST-NEUTRON REACTORS FUELED WITH HIGHLY ENRICHED UO_2 OR PuO_2 AND REFLECTED WITH CARBON, BERYLLIUM METAL, OR BERYLLIUM OXIDE. Smith, O. L.; Perry, A. M. (Oak Ridge National Lab., Tenn.). Feb. 1967. Contract W-7405-eng-26. 36p. Dep. CFSTI.

As part of the initial design phase of the MPRE program, a neutronic feasibility study is presented for a compact, lightweight reactor fueled with highly enriched U or Pu, cooled with boiling K and reflected with BeO. At the time this study was made a series of beryllium- and carbon-reflected, UO_2-fueled critical experiments was anticipated. A set of one-dimensional calculations performed to give basic neutronic data for use in designing the experiments is described. The results of a generalized parametric investigation of the basic reactor concept are presented. (auth)

28591 MEASURED AND CALCULATED ABSOLUTE POWER AND FISSION DISTRIBUTION IN THE TSF-SNAP REACTOR. Straker, E. A.; Muckenthaler, F. J. (Oak Ridge National Lab., Tenn.). Nucl. Appl., 6: 274-8(Apr. 1969).

The relative power distribution in the TSF-SNAP Reactor was determined by scanning individual fuel elements for fission-product gamma rays, and the absolute fission rate was determined from uranium-foil activation. Numerical integration of the fission density over the core volume gave an absolute power calibration for detectors and foils external to the core. Calculations of both the axial and radial power distributions by Monte Carlo and discrete ordinates methods were in excellent agreement with the measured distributions. (auth)

Process Heat and Desalination Reactors

Refer also to abstract 28423.

28592 (AEEW-M-846) A DESCRIPTION OF THE NUMERICAL METHODS USED IN FIFI 3B. Wilson, P. T. (Atomic Energy Establishment, Winfrith (England)). Oct. 1968. 12p. Dep. CFSTI. UK.

FIFI 3B is a Fortran program used in the analysis of plant dynamics for solving first order linear or nonlinear differential equations. The method of integration is centered on a stable multistep algorithm which uses a predictor-corrector method with relaxation. General numerical integration methods are discussed, with emphasis on their application to the code FIFI. (UK)

28593 (ORNL-4409) NUCLEAR DESALINATION PROGRAM. Annual Progress Report for Period Ending October 31, 1968. Anderson, T. D.; Thompson, W. E. (comps.) (Oak Ridge National Lab., Tenn.). Apr. 1969. Contract W-7405-eng-26. 122p. Dep. CFSTI.

The results of development and engineering activities on the use of nuclear reactors in large scale desalting plants are summarized. General areas of study include: analysis of desalting plant system coupling, dual-purpose plant control, large plant siting and safety features, agro-industrial complexes, desalination reactor design and evaluation, and the technological and economic feasibility of nuclear desalting plants for the southwest U. S. and northwest Mexico and for the Middle East. The idea of agro-industrial complexes received considerable attention, and detailed studies were initiated of production capabilities for industrial and agricultural products and economic aspects of such complexes in specific regions. Study of reactors for desalting applications concentrated in the area of uranium-metal-fueled pressurized-water and sodium-cooled reactors. (H.D.R.)

28594 (ZJE-41) APPLICATIONS OF MEDIUM-SIZE POWER REACTORS FOR PROCESS AND SPACE HEAT. Hulovec, J. (Skoda Works, Pilsen (Czechoslovakia). Nuclear Power Plant Div.). [1968]. 11p. (CONF-680652-1). Dep.

From Panel on Small and Medium-Size Power Reactors, Vienna, Austria.

The technical and economic aspects of using central nuclear heating stations to supply industrial process steam and space heat are examined. Specific heat requirements and economic data are compared for conventional and nuclear heating plants installed at two Czechoslovak towns. 5 references. (H.D.R.)

28595 BRINE-HEATER LEAKAGE-CONTROL PROBLEMS IN LARGE POWER-DESALTING PLANTS. Kelley, W. H. Jr. (Oak Ridge National Lab., Tenn.). Reactor Fuel-Process. Technol., 12: No. 1, 80-7(Winter 1968-69).

Brine-heater leakage problems in large nuclear dual-purpose power-desalting plants utilizing light-water reactors and multistage flash evaporators are analyzed. Leakage of reactor condensate into the water plant was found to have an inconsequential effect on product-water purity. Leakage of brine into the reactor presents a considerable problem in demineralization or blowdown-and-makeup cost. The best presently available solution to the demineralization problem appears to be the use of a coated-filter ion-exchange unit, with immediate shutdown of a leaking brine heater. An installed spare brine heater was found to be economically attractive in preventing loss of power and product-water revenues. The use of vertical tube evaporators (VTE's) in place of or in conjunction with the conventional brine heaters would ensure against leakage of brine into the reactor plant. Several schemes utilizing VTE's appear economically attractive. 7 references. (auth)

28596 STUDY OF SEA-WATER DESALINATION PLANTS ASSOCIATED WITH A NATURAL URANIUM-GAS-GRAPHITE TYPE NUCLEAR REACTOR AND OPERATING WITH DIFFERENT DISTILLATION PROCESSES. Balligand, P; Agostini, J. P.; Huyghe, J.; Lauro, F.; Vignet, P. (CEN, Grenoble, France). Bull. Inform. Sci. Tech. (Paris), No. 133, 5-17(Jan. 1969). (In French).

It is possible, in conventional expansion or multiple action distillation methods, to eliminate completely the risk of salt deposits by keeping the evaporation lines on the calcium sulphate solubility diagram below the anhydrite saturation curves. However this obligation limits the operational temperature range and consequently the production of water. If the evaporation line is limited by the hemihydrate saturation curve, the risk of salt deposits exists but the water production increases according to hypotheses, and for four different processes, water plants associated with a nuclear reactor of the uranium-gas-graphite type are examined, and examples of application under given economic conditions are discussed. (auth)

Marine and Portable Power Reactors

28597 RESULTS OF THE IRRADIATION RESEARCH ON THE FDR PRESSURE VESSEL OF THE OTTO HAHN. Schmelzer, F. pp 43-50 of Reaktordruckgefaess-Staehle und ihr Verhalten Unter Bestrahlung. Fischer, E.; Melkonian, G. A. (eds.). Muenchen, Verlag Karl Thiemig KG, 1968. (In German).

From Conference on Radiation Effects on Materials, Geesthacht, West Germany. See CONF-670336.

The results of notch impact strength measurements made after long-term irradiation on the steel of the FDR pressure vessel were reported. These results indicate that the safety against brittle fracture is not altered by the highest irradiation doses that can be attained during the life of the pressure vessel. (J.S.R.)

28598 DEVELOPMENT OF THE FDR-PRESSURE VESSEL STEEL FOR THE NUCLEAR RESEARCH SHIP OTTO HAHN. Goedecke, F.; Opel, P.; Florin, C. (Stahl- und Roehrenwerk Reisholz GmbH, Duesseldorf, Ger.). pp 11-30 of Reaktordruckgefaess-Staehle und ihr Verhalten Unter Bestrahlung. Fischer, E.; Melkonian, G. A. (eds.). Muenchen, Verlag Karl Thiemig KG, 1968. (In German).

From Conference on Radiation Effects on Materials, Geesthacht, West Germany. See CONF-670336.

Extensive preliminary studies led to the preparation of a steel whose analysis values and mechanical properties corresponded to the reactor requirements for the pressure vessel. Seven steels were tested. The properties and acceptance values of the steel are tabulated. The results of the brittle fracture research on the seven steels are reported. The steel selected was 15 MnMoNiV 53, and the further development studies planned for this steel are indicated. (J.S.R.)

Reactor Theory

28599 (EURFNR-612) COMMENT ON THE CALCULATION OF NEUTRON LIFETIME AND MATERIAL WORTH. Kiefhaber, E. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Nov. 1968. 9p. (KFK-882; EUR-4161). Dep.

Work Performed under United States-Euratom Fast Reactor Exchange Program.

Bilinear averaging has been widely accepted as the adequate procedure for establishing few group perturbation cross sections. The most important differences compared to the usual flux-averaging procedure are generally obtained for the material worths especially of predominantly scattering materials. In addition to these results a strong indication is given that the calculation of the neutron lifetime is also markedly influenced by the averaging scheme used, leading to an underprediction of the calculated value, a fact which is most times observed in comparison with experimental results. 7 references. (auth)

28600 (GA-8716) NEUTRON KINETICS IN SUBCRITICAL AND NONMULTIPLYING SYSTEMS. d'Oultremont, P. (Gulf General Atomic, Inc., San Diego, Calif.). June 4, 1968. Contract AT(04-3)-167. 43p. (EURAEC-2079). Dep. CFSTI.

Work Performed Under United States-Euratom Joint Research and Development Program.

An iterative solution to the diffusion approximation of the steady-state Boltzmann equation for reactor kinetics is given. The Fredholm integral of the second kind is transformed to the Fredholm integral of the first kind by assuming an expansion in the neutron flux. This transformation, then, leads to a definition of thermal equilibrium for the neutron population. Time-energy calculations for three fast subcritical assemblies are described; results of calculations are shown graphically. Time analyses for two thermal systems are detailed; data are included. The CAGE FORTRAN-IV program, used for the numerical calculations, is described. 19 references. (M.L.S.)

28601 (IN-1282) MVFC: A COMPUTER PROGRAM FOR CONSTRUCTING FORCE CONSTANT MATRICES FOR USE IN VALENCE FORCE POTENTIAL FUNCTIONS IN MOLECULES AND CRYSTALS. Boyter, J. K.; McMurry, H. L. (Idaho Nuclear Corp., Idaho Falls). Apr. 1969. Contract AT(10-1)-1230. 82p. Dep. CFSTI.

The program described is to become part of a collection of computer programs which provide the means for calculating the slow-neutron scattering by moderators. This scattering depends on the vibrations of the atoms in the moderating materials and these vibrations must first be calculated before the scattering can be determined. This program automates what has been one of the most time consuming and error producing processes required for preparing input to programs which calculate the vibrations of molecular and crystalline moderators. Specifically, it sets up the force constant matrices which are used when valence force coordinates (changes in bond distances, interbond angles, etc.) are used to express the potential energy changes which occur during the vibrations. 7 references. (auth)

28602 (RFP-1134) COLLISION PROBABILITY CRITICALITY CALCULATIONS. Hunt, Douglas C. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Apr. 16, 1969. Contract AT-(29-1)-1106. 8p. Dep. CFSTI.

A method is presented for computing the multiplication factor of single region systems which contain fissile material and which may be specified by one, two, or three coordinates. The systems are assumed to be unreflected, homogeneous assemblies which have no reentrant surfaces. The method follows the successive scattered neutron collisions which take place in a system and computes for each interaction the product of the probability of a fission collision and the average number of secondaries per fission. The sum of these products, in the limit as the number of collisions become infinite, is the multiplication factor of the system. Critical sizes are found by obtaining the multiplication factor as a function of the system dimensions and graphically determining the dimensions which make the factor equal unity. The critical dimensions of several plutonium metal and enriched-uranium metal systems are computed and, when possible, the calculated dimensions are compared with experimental values. (auth)

28603 CRITICAL PARAMETERS OF PLUTONIUM SYSTEMS. PART II. INTERPRETATION. Hansen, L. E.; Clayton, E. D. (Battelle Memorial Inst., Richland, Wash.). Nucl. Appl., 6: 381-90(Apr. 1969).

Lack of experimental data for nuclear criticality control over operations with plutonium necessitates the use of computed critical parameters for guidance. To provide guidelines for criticality safety use, survey calculations for unreflected and water reflected spheres, semi-infinite cylinders, and semi-infinite slabs were made using calculational techniques confirmed by available experimental data. The Pu(metal)-water mixtures examined cover the entire range of possible moderation ratios and have isotopic ^{240}Pu contents of ≤20%. Critical experiment data for water-reflected spherical systems containing $Pu(NO_3)_4$ solutions with ≤435 g Pu/liter at 4.6 wt % ^{240}Pu were extrapolated by means of calculations to ^{239}Pu(metal)-water mixtures for a direct comparison between calculations and experimentally derived critical parameters. The effect of ^{240}Pu on criticality was examined as a function of both concentration and geometry. The manner in which ^{240}Pu affected the minimum critical mass of Pu(metal)-water systems was also determined. (auth)

28604 CRITICAL PARAMETERS OF PLUTONIUM SYSTEMS. PART I: ANALYSIS OF EXPERIMENTS. Hansen, L. E.; Clayton, E. D.; Lloyd, R. C.; Bierman, S. R.; Johnson, R. D. (Battelle Memorial Inst., Richland, Wash.). Nucl. Appl., 6: 371-80(Apr. 1969).

To predict the critical parameters of plutonium fueled systems one must establish the accuracy of the computational methods to be employed and the accuracy and applicability of the available critical experiment data with which the calculations are to be compared. The accuracy of a multigroup diffusion theory code, HFN, and a multigroup transport theory code, DTF-IV, was examined by analyzing recent plutonium critical experiments. The experiments cover the entire range of possible moderation ratios, and the plutonium fuels contain as much as 23.2 isotopic percent ^{240}Pu. All three basic geometries are represented by the experimental data examined. Where necessary, the criticality data were corrected, by means of additional experiments and/or calculations, to conform to one-dimensional, clean, homogeneous critical assemblies which could be adequately defined and used as a basis for establishing nuclear criticality safety guidelines. 22 references. (auth)

28605 APPLICATION OF LOW CRITICAL MASS STUDIES TO REACTOR DESIGN. Brasier, Robert I.; King, L. D. P.; Mills, Carroll B. (Los Alamos Scientific Lab., N. Mex.). Nucl. Appl., 6: 266-73(Apr. 1969).

Recent theoretical and experimental work has established minimum critical masses for U and Pu reactor fuels. Studies at Los Alamos show a minimum of 300 to 600 g in the critical mass of ^{235}U for H_2O or D_2O moderator and D_2O or Be reflectors. A H_2O-moderated, Be-reflected core containing 0.070 g ^{235}U per ml has a very low critical mass, which is of interest in the design of small power reactors and has attractive features for a new high neutron flux reactor concept. Nuclear parameter studies are related to specific design objectives and the importance of special effects of geometry and materials to such studies is shown. (auth)

28606 THE USE OF THE KALMAN FILTER FOR THE ESTIMATION OF NUCLEAR REACTOR PARAMETERS. Habegger, Loren James. Lafayette, Ind., Purdue Univ., 1968. 151p.

Thesis.

The identification of parameters in nuclear reactor systems has been accomplished through the use of the linearized Kalman filter. In the Kalman filter, the parameter estimates in a system dynamics model are adjusted so that the transients predicted by the model agree with measured transients. The technique is applicable to nonlinear systems and systems with time varying coefficients. The effects of both measurement noise and system input noise are considered in the estimation. (Disser. Abstr.)

28607 TWO-GROUP CALCULATION OF THE FAST FISSION FACTOR IN A LATTICE WITH CLUSTERED FUEL ELEMENTS. Bonalumi, R.; Palazzi, F.; Pierini, G. (Laboratori CISE, Milan). Energ. Nucl. (Milan), 16: No. 5, 1-16(May 1969).

A synthetic method for the calculation of the fast fission factor in a lattice with clustered fuel elements is described. The fast fission factor is defined as the number of neutrons slowing down past 0.1 MeV throughout a lattice cell per neutron arising there from fissions below 0.1 MeV, in an infinite lattice. Such a definition is well adapted to a 4-group lattice code, but implies that cell-to-cell interaction, (n,2n) reactions and back-scattering effects should be carefully accounted for. Such requirements are met by dividing fast neutrons into two groups (above and below the ^{238}U fission threshold), and by using a first collision probability scheme, where non-uniformity of sources in the fuel elements and in the moderator is explicitly taken into account. 12 references. (auth)

28608 GRAPH-ANALYTIC CALCULATIONS OF THE POISONING OF A NUCLEAR REACTOR BY SAMARIUM. Vladimirov, V. I.; Sergeev, V. S. Morsk. Sb., No. 7, 75-81(1968). (In Russian).

One of the processes accompanying the operation of a nuclear reactor, is poisoning of the active zone with ^{149}Sm arising as a result of the β-decay of ^{149}Pm, a direct fission product, and from the radioactive decay of the fission fragment ^{149}Nd. Such a poisoning adversely affects the rated energy of the reactor by reducing the reactivity margin. A graph-analytic method for calculating the variation in the concentration of Sm during steady-state and transient modes of reactor operation is presented. To this end, a system of two differential equations is solved. One determines the rate of variation in the concentration of promethium as the difference between the rates of its build-up and decay and the other, the rate of variation in the concentration of samarium as the difference between the rate of its production by the decaying promethium and the rate of its annihilation by the neutron flux. A formula is derived for the variation in reactivity due to the build-up of samarium during operation of the reactor in steady-state mode. The formula can be utilized to plot curves showing poisoning with Sm at any time during the operation and life of the reactor at various power levels. (JPRS)

28609 ACCURACY OF THE QUASISTATIC TREATMENT OF SPATIAL REACTOR KINETICS. Ott, K. O. (Purdue Univ., Lafayette, Ind.); Meneley, D. A. Nucl. Sci. Eng., 36: 402-11 (June 1969).

The quasistatic approach of treating the spatial dynamics problem is described as one method out of a full sequence of methods that factorize the flux into an amplitude and a shape function. The accuracy of these methods is investigated for a wide range of excursions in fast and thermal reactors by comparison with a full numerical solution. The quasistatic method describes even extreme excursions in fast reactors very accurately. Its application to thermal reactor excursions may, however, lead to appreciable errors. The "improved quasistatic" method reduces the errors for both types of reactors to negligible amounts so that its application to thermal reactors may be also considered. (20 references) (auth)

28610 CALCULATION OF TEMPERATURE DISTRIBUTIONS IN FUEL RODS WITH VARYING CONDUCTIVITY AND ASYMMETRIC FLUX DISTRIBUTION. Andrews, D. G.; Dixmier, M. (Univ. of Toronto). Nucl. Sci. Eng., 36: 259-67(June 1969).

The temperature distribution in a cylindrical fuel rod has been calculated on the assumption that the flux distribution is expressible in the form of a series of Bessel functions, whether or not it actually obeys the simple diffusion equation. Variable thermal conductivity has been taken into account and a generalization of the classical solution has been obtained. A simplified design formula for a solid rod has been derived. (auth)

28611 AN ANOMALY ARISING IN THE COLLAPSED-GROUP FLUX SYNTHESIS APPROXIMATION. Adams, C. H.; Stacey, W. M. Jr. (General Electric Co., Schenectady, N. Y.). Nucl. Sci. Eng., 36: 444-7(June 1969).

An anomaly encountered in a flux-weighted collapsed-group synthesis problem is described. The difference between group dependent and collapsed-group synthesis is defined. In the collapsed-calculations the expansion functions are used in the dual role of weighting function shapes. The reactor model to which this procedure is applied is shown; the group cross sections, used in the calculations, are defined. Results of numerical evaluation are compared, graphically, for group-dependent and collapsed-group calculations; this comparison shows the anomaly. Causes for the anomaly are analyzed. (11 references) (M.L.S.)

28612 DISCRETE ENERGY REPRESENTATION OF THERMAL-NEUTRON SPECTRA IN URANIUM–PLUTONIUM LATTICES. Fredin, B. (Aktiebolaget Atomenergi, Stockholm); Bosevski, T.; Matausek, M. Nucl. Sci. Eng., 36: 315-25(June 1969).

A method of discrete representation of thermal neutron spectra, especially suitable for U–Pu systems has been developed. The energy points and corresponding integration weights have been determined so as to provide accurate reaction rates in U–Pu lattices, the total number of points being considerably less than the necessary number of groups in multigroup treatment. Furthermore, a convenient method of scattering matrix construction has been proposed and the system of multipoint equations, formally identical to multigroup equations, has been derived. The proposed method has been tested by calculating thermal reaction rates and energy spectra in a pin cell and comparing with the group method. Some results are given. (9 references) (auth)

28613 NEUTRON FLUX AND IMPORTANCE DISTRIBUTION BY COLLISION METHOD, STARTING FROM A GENERALIZED SOURCE. Bitelli, G.; Salvatores, M. (Comitato Nazionale per l'Energia Nucleare, Rome). Nucl. Sci. Eng., 36: 309-14(June 1969).

A multigroup method in finite monodimensional geometry is presented for neutron distribution calculation from a given source distribution. This method is extended to neutron importance function calculation for a given detector distribution. Furthermore, it is shown how truncating the calculation at whatever collision, it is possible to evaluate the residual neutron distribution by means of usual methods in diffusion or transport theory. An application is presented related to the generalized perturbation methods and the numerical solution of problems of general interest. (9 references) (auth)

28614 APPLICATION OF THE j_N METHOD TO NEUTRON TRANSPORT IN SLABS AND SPHERES. Kschwendt, H. (EURATOM, Ispra, Italy). Nucl. Sci. Eng., 36: 447-50(June 1969).

Equations describing neutron behavior in a finite system are derived. The kernel in the integral form of the transport equation is transformed, by a Fourier transformation, to obtain the critical parameters of the system. Conditions on the matrix elements of the equations are defined; approximate solutions and degenerate solutions are given. (14 references) (M.L.S.)

28615 EQUIVALENCE OF INTEGRAL TRANSFORM AND SPATIAL SPHERICAL HARMONICS METHODS. Mika, J.; Stankiewicz, R. (Inst. of Nuclear Research, Swierk, Poland). Nucl. Sci. Eng., 36: 450-3(June 1969).

The equivalence of the integral transform and spatial-spherical harmonics methods for solving the neutron transport equations is discussed. Equations for both methods are developed from the one-velocity isotropic scattering transport equations. The formalism showing the equivalence of the integral and integro-differential forms of the transport equation for zero boundary conditions in the Hilbert space of square summable functions is developed. (11 references) (M.L.S.)

28616 COLLISIONAL IMPORTANCE AND ADJOINT PROBLEMS IN NEUTRON TRANSPORT. Nelson, Paul Jr. (Sandia Labs., Albuquerque, N. Mex.). Nucl. Sci. Eng., 36: 453-5 (June 1969).

The physical significance of the eigenfunctions of the adjoint integral equation is discussed; adjoints are defined relative to their inner products. The equations defining collisional importance are formulated. (10 references) (M.L.S.)

28617 SPACE-ANGLE SYNTHESIS. Swibel, Harry S. (Battelle-Northwest, Richland, Wash.); Bowes, Bradley. Nucl. Sci. Eng., 36: 435-8(June 1969).

Application of the space-synthesis critical slab and subcritical fixed source problems is described. Spatial functions are chosen for variational synthesis solution to the Boltzmann transport equation and the angular functions are determined. Results of numerical evaluation of the Boltzmann equation solutions are tabulated. (M.L.S.)

28618 SOURCE CONVERGENCE IN MONTE CARLO CALCULATIONS. Carter, L. L.; McCormick, N. J. (Univ. of Washington, Seattle). Nucl. Sci. Eng., 36: 438-41(June 1969).

A method for improving source convergence for solution to the steady-state transport equation for critical assemblies is described. The technique involves a matrix formulation solved by an iteration procedure which assumes an initial source distribution. Monte Carlo values are then used for the number of first-generation fission neutrons and the calculated source distribution; from this, a normalized source distribution can be found. Number of iterations is shown as a function of computed multiplication factor; matrix and non-matrix methods are also compared. (M.L.S.)

28619 STOCHASTIC KINETIC THEORY FOR A SPACE- AND ENERGY-DEPENDENT ZERO POWER NUCLEAR REACTOR MODEL. Stacey, Weston M. Jr. (Knolls Atomic Power Lab., Schenectady, N. Y). Nucl. Sci. Eng., 36: 389-401(June 1969).

A stochastic kinetic theory for space- and energy-dependent zero power, nuclear reactor models is constructed from a last collision probability argument. The space and energy domains are partitioned into discrete cells. Equations are developed for the probabilities for transitions among the possible states of the reactor, and an equation is obtained for the probability generating function for these transition probabilities. Equations for the mean values, variances, covariances and correlation functions of the neutron and precursor distributions are derived. The stochastic distributions of neutrons and precursors are found to be space-

and energy-dependent in subcritical reactors, but to attain a space- and energy-independent asymptotic form in subcritical reactors. The asymptotic distribution in a supercritical reactor is identical for the neutron and precursor distributions, and depends upon the manner in which the reactor is made supercritical. A method for applying the theory to low-source start-up calculations is suggested. The influence of spatial stochastic effects upon such calculations is demonstrated. (29 references) (auth)

28620 REVIEW OF NONLINEAR NUCLEAR REACTOR STABILITY. Shah, S. K.; Sastry, V. R. (Indian Inst. of Tech., Kanpur, India). Nuclear Energy, 48-50; 55-7(Mar.-Apr. 1969).

Work done in the field of nonlinear nuclear reactor stability is briefly reviewed. Some of the important and widely used mathematical models are described. For stability analysis of certain reactor models, the procedure for the construction of Liapunov functions is indicated. Different reactor stability criteria and their relative merits are discussed. The effect of delayed neutrons on the stability of a reactor is pointed out. Two approaches to the stability analysis of reactors, considering them as distributed parameter systems, are indicated. (auth) (UK)

Experimental Applications

28621 (RISO-M-850) CALCULATION OF HETEROGENEOUS CONSTANTS FOR CYLINDERS AND SLABS. Pedersen, J. (Danish Atomic Energy Commission, Risoe. Research Establishment). Jan. 27, 1969. 23p. Dep.

A method for computing the heterogeneous constants for fuel- or control-elements by collision-probability-theory is given. These constants are directly used in heterogeneous reactor codes, but it is also shown, that they may be used for a consistent calculation of cell average cross sections and diffusion constants. A computer code HECS (HEterogeneous ConStants), being able to compute cylindrical monopoles or dipoles and slabs with symmetrical or skew-symmetrical flux distributions, is described. (auth)

28622 (RISO-M-865) THE EFFECTIVE RESONANCE INTEGRAL OF ^{238}U. Mikkelsen, Joern (Danish Atomic Energy Commission, Risoe. Research Establishment). Mar. 1969. 17p. Dep.

The resonance integral of ^{238}U in homogeneous infinite mixtures has been expressed as a function of temperature and excess scattering. The formula is based on calculations, using the programme RESAB, which includes the influence of scattering interference. For mixtures, containing UO_2, the right slowing down kernel for O is incorporated. It is demonstrated, how the result can be used to calculate the resonance integral of U-metal rods and UO_2 rods. A comparison with the measurements of E. Hellstrand is carried out. The deviation is 1 to 3%. 32 references. (auth)

28623 DENSITY SCALING OF THE BOLTZMANN EQUATION AND ITS APPLICATION. Gozani, Tsahi; Stevens, C. A. (Gulf General Atomic Inc., San Diego, Calif.). Contract AT(04-3)-167. J. Nucl. Energy, 22: 751-7(1968). (GA-8454).

A general treatment of density and macroscopic cross-section scaling in systems is presented. The advantages of the scaling procedure and its applications are demonstrated for a wide range of experiments in reactor physics and related areas. The use of the method in a number of applications allows the conduct of experiments which would not otherwise be feasible. 13 references. (auth)

28624 NOISE IN NUCLEAR REACTORS. Kempkes, A. Ned. Tijdschr. Natuurk., 34: 369-81(Dec. 1968). (In Dutch).

Some examples are given of the use of noise analysis in nuclear reactors. The difficulties and limitations were not considered. The examples showed that noise analysis with the help of special measuring instruments led to good results. 43 references. (J.S.R.)

28625 REACTOR-NOISE STUDIES WITH AN ON-LINE DIGITAL COMPUTER. Cohn, Charles Erwin (Argonne National Lab., Ill.). Nucl. Appl., 6: 391-400(Apr. 1969).

A method for determining the prompt neutron decay constant of a fast critical assembly by noise analysis has been developed. It uses a digital computer to do polarity cross-correlation on the outputs of two scintillation detectors. For the first time, such a measurement has been made in a fast assembly at criticality with no intrinsic limitation on power level. Portions of the technique were adapted for a study of the dynamics of a digital reactor control scheme. (auth)

28626 ECONOMICAL EXPERIMENTAL METHODS OF NUCLEAR REACTOR PHYSICS STUDYING. Zhezherun, I. F. At. Energ. (USSR), 26: 353-61(Apr. 1969). (In Russian).

A short review of economical experimental methods of nuclear reactor physics is given. These methods are more or less alternative to usual critical ones, but require smaller amounts of materials and work. The review concerns mainly the experiments of the neutron parameter measurements of the thermal and intermediate multiplication assemblies and does not concern such special questions as neutron thermalization, differential spectrum measurements, and safety physics. (60 references) (auth)

28627 NEUTRON DIFFUSION IN ALUMINUM-WATER LATTICES: MEASUREMENTS OF ANISOTROPY IN THE CONTINUOUS EIGENVALUE REGION. Palmedo, Philip F.; Conant, John F. (Brookhaven National Lab., Upton, N. Y.). Nucl. Sci. Eng., 36: 326-35(June 1969).

A series of experiments has been performed to study the diffusion of thermal neutrons in $Al-H_2O$ plate lattices. Although diffusion perpendicular to the plates could be described by an exponential function, thus defining a diffusion length, such was not the case for diffusion parallel to the plates. Various ancillary experiments support the conclusion that a discrete eigenvalue does not exist for parallel diffusion in such systems. (32 references) (auth)

28628 NEUTRON RETHERMALIZATION NEAR A TEMPERATURE DISCONTINUITY BETWEEN TERPHENYL AND LIGHT WATER. Rastas, A.; Saastamoinen, J. (Technical Univ. of Helsinki, Otaniemi, Finland). Nucl. Sci. Eng., 36: 351-60(June 1969).

Neutron rethermalization has been studied, experimentally and theoretically, in a system intended to reproduce the conditions of the Kottwitz problem. Terphenyl and light water were used as the moderators at the temperatures 223 and 11°C, respectively. The energy spectrum of the angle-dependent neutron flux perpendicular to the plane discontinuity was measured in terphenyl as a function of the distance from the discontinuity by means of an extraction channel and a chopper-time-of-flight analyzer. The spatial behavior of the flux-weighted average energy was determined by fitting a Maxwellian to each measured spectrum using the method of the least squares. This spatial behavior could be satisfactorily described by a simple one-exponential function for distances exceeding 3 mm (measured from the discontinuity). The least-squares fit gave a value of 11.3 mm for the relaxation length. The theoretical calculations were performed by an approximate method using the "two overlapping-groups" approximation for the energy dependence. For the angular dependence of the flux, both the P_n- and the DP_n-approximations were used. Three different scattering models were used for each moderator. (31 references) (auth)

28629 SPACE-TIME KINETICS FOR HOMOGENEOUS AND HETEROGENEOUS REACTOR MODELS. Saji, Genn. Urbana, Ill., Univ. of Illinois, 1968. 163p.
Thesis.

The first section describes an investigation of the excitation of higher space modes in reactor transfer function measurements. An explicit time-dependent two-group flux, expressed by a series of space modes, is established when a forced oscillation is applied to a reactor. The self-consistent time-dependent method developed minimizes necessary mathematical transformations, and enables one to clearly visualize the physical reasons why the higher space modes are only excited at high frequencies. The conditions necessary for a particular higher space mode to be appreciably excited and detected are discussed in detail. The results show that the major factor is due to the increase of the input frequency as compared with the decay constants of several higher space modes at high frequencies. This method was applied to the NORA reactor for which the space-dependent transfer functions have been measured. Results of the calculations closely agree with the published experimental results, as well as with theoretical gain and phase shift curves obtained by the conventional modal expansion-the Laplace transform method. The relative amplitude heterogeneous reactor models are related in the sense that the basic formalism developed is applied to the forced oscillation problem which is a theoretical description of reactor transfer function measurements. In fact, amplitudes and phase angles of oscillations calculated for heterogeneous reactors in the second are gain and phase angles of the transfer functions. (Disser. Abstr.)

Reactor Components, Fuels, and Accessories

Refer also to abstracts 26226, 26416, 26421, 26424, 26431, 26479, 26490, 26509, 26614, 26984, 26997, 27026, 27087, 27090, 27149, 27158, 27164, 27201, 28423, and 28651.

28630 (KFK-858) TESTING OF IODINE FILTERS FOR NUCLEAR INSTALLATIONS. Wilhelm, J. G. (Kernforschungszentrum, Karlsruhe (West Germany)). Nov. 1968. 20p. (CONF-680811-15). Dep.

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive wastes, New York.

The removal efficiency of iodine filters for nuclear installations is analyzed. The test method in use includes laboratory tests of the adsorber material (under MCA-conditions for temperature, relative humidity, pressure, loading, stay-time and bed depth) and in-place tests at the site of the installation. For removal of methyl iodide under high relative humidity, KI-impregnated charcoal is widely used. Most of the data for charcoal removal efficiency available today result from experiments with tracer amounts of $CH_3{}^{131}I$, mixed with $CH_3{}^{127}I$. Considering MCA-conditions, the validity of those data should be confirmed for specific activities on charcoal 10^3 to 10^6 times higher. Experimental data are given for realistic loadings with $CH_3{}^{131}I$ up to 1.0 Ci/g charcoal under 100% relative humidity. For standard laboratory adsorber tests a method is discussed for humidification and control of gas streams up to 100% relat. humidity at elevated temperatures; the apparatus used is described. Experimental data are given for the removal efficiency and the adsorption of water in charcoal samples from long-time tests under 100% relat. humidity. The overall test period was up to 98 hr, simulating the phase of elevated pressure and, therefore, high iodine release from the reactor containment. The reproducibility of long-time tests under extremely high relative humidity is shown and discussed. A description of the hardware for in-place tests is included, results are given. 4 references. (auth)

28631 (N-69-17701) EXPERIENCE WITH AND IMPROVEMENTS IN CONTAINMENT VESSEL PENETRATIONS. Conant, Charles W. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Feb. 1969. 19p. (NASA-TM-X-1735). CFSTI.

Early containment vessel leak rate tests showed that potted electrical penetrations were a major contributor to the containment vessel leakage. This type of penetration was largely replaced with hermetic penetrations. Leak rate testing of the hermetic penetrations is done by the pressure decay method having a sensitivity better than 0.001 ft^3/day (2.8×10^{-5} m^3/day). The tests show that the average penetration leak rate is less than 0.003 ft^3/day (8.5×10^{-5} m^3/day). The use of hermetic penetrations has significantly reduced leakage through electrical penetrations, reduced maintenance, and reduced effort required to change cables penetrating the containment vessel. (auth) (STAR)

28632 (TRG-Report-1499) A STUDY OF THE FUNDAMENTALS OF LONGITUDINAL WRINKLING IN FUEL ELEMENT CANS. Bunyaraksh, S. (Cambridge Univ. (England). Dept. of Engineering); Calladine, C. R. (United Kingdom Atomic Energy Authority, Springfields (England). Reactor Group). Apr. 28, 1967. 68p. Dep. CFSTI. UK 9s. 0d.

An experimental and theoretical investigation of the creep and yield longitudinal wrinkling of fuel element cans was carried out. The experimental work involved observation of wrinkle development on scaled-up rings, under creep conditions at steady pressure, and under a steadily increasing pressure. The theoretical work extended earlier results to cover the wrinkling of thin tubes during creep and the wrinkling of cans with elastic-plastic properties. A number of parameters in addition to fuel-can gap and simple geometry were found to be important. In creep, number of wrinkles, the can-fuel friction conditions, and the extent of the non-linearity of the creep law were important. For elastic-plastic behavior the yield strain replaced the creep law as an important parameter. 11 references. (auth)

28633 THE FUEL CYCLE FOR NUCLEAR MATERIAL AND ITS ECONOMIC IMPORTANCE. Oszuszky, Friedrich Johann P. (Oesterreichische Verbundgesellschaft, Vienna). At. Strom, 15: 38-43(Feb.-Mar. 1969). (In German).

General studies were made on nuclear fuel cycles and an actual fuel cycle for a light-water reactor is discussed. Extraction of the raw material, primary fabrication, enrichment, manufacture of the fuel elements, use in the reactor, and reprocessing for further use in another cycle are described. (auth)

28634 REACTIVITY CONTROL SYSTEMS. Davis, Dennis (to English Electric Co. Ltd.). British Patent 1,150,358. Apr. 30, 1969. Filed Nov. 30, 1965.

A reactivity control system for nuclear reactors with positive moderator temperature coefficients of reactivity is described. The control system is responsive to temperature sensing means whereby the reactor power output is maintained at the highest value consistent with permissible temperatures. At least one temperature sensing means is located at an intermediate section of the core, so as to measure the local temperature of coolant fluid flowing through the core or the local temperature of the moderator itself. This sensing means is preferably located about halfway along the core. If direct measurement of the moderator temperature is made by the first sensing means the actual coolant outlet temperature is also measured and the two values compared using a comparator to give a suitable output signal for controlling the reactivity control means. (UK)

28635 NUCLEAR REACTORS. Raven, Anthony David (to English Electric Co. Ltd.). British Patent 1,150,357. Apr. 30, 1969. Filed Oct. 28, 1965.

The winding mechanisms for reactor control rods are described which include a first group arranged to be driven at a predetermined speed, and a second group driven at a second predetermined speed. The common drive unit comprises a motor arranged to drive the winding mechanisms of either group simultaneously at the appropriate speeds, and selective coupling means arranged to couple the motor selectively with each group of winding mechanisms. The winding mechanisms may be arranged to operate fast acting shutdown rods, and control rods operated at a slower speed. The system can be applied to any reactor having a pile cap. The motion transmitting means may comprise rotatable shafts or chain drives. (UK)

28636 CONCENTRIC MULTIPLE-CYLINDER NUCLEAR FUEL ELEMENT. Nakai, Yasushi (to Mitsubishi Atomic Power Industry, Inc.). Japanese Patent 1968-28511. Dec. 7, 1968. Filed Feb. 2, 1966.

A fuel element is described in which a plurality of long arc fuel plates were arranged outside the inner tube forming a plurality of the fuel cylinders; the outer tube completing the element. The fuel element consists of the inner tube, axial plates at right angles to the outside of the inner tube, axial spacer plates attached to both sides of the axial plate with axial grooves, arc fuel plates supported by insertion into the grooves, and the outer tube welded to the end of the axial plates with some distance from the outmost arc plates. (NSA of Japan)

28637 FUEL ELEMENTS. Howard, Ronald A.; Kellar, Arnold A.; Meers, Joseph T. (to Union Carbide Corp.). U. S. Patent 3,438,858. Apr. 15, 1969. Filed Sept. 29, 1966.

A fuel element for use in nuclear reactors is described which has a fueled core encompassed within an unfueled graphite extension shell. The fueled core comprises a mixture of a nuclear fuel material, a high temperature matrix, expanded graphite and a carbonized bond. The use of expanding graphite in the core of the fuel element provides for continuous contact between the core and outer graphite shell by overcoming the shrinkage which occurs when the fueled core is placed in the solid graphite exterior shell and baked to carbonize the binder. If desired, bonding between the core and shell can be provided by a layer of carbonaceous cement containing expanded graphite. (Offic. Gaz.)

28638 THERMAL BOWING IN PIN-TYPE FUEL RODS. Anderson, C.; Anderson, R.; Baer, R.; Lobbin, F.; Riggs, R. (Hittman Associates, Inc., Columbia, Md.). Reactor Fuel-Process. Technol., 12: No. 1, 88-97(Winter 1968-69).

An iterative process was formulated and utilized to determine the complex interaction between bowed fuel rods and the channel thermal hydraulics of a water reactor. The methods used and the results are described. Fuel rod thermal instability can be circumvented by proper specification of the tolerances between the fuel rod and its end supports or by the use of intermediate supports. Typical results for the case of end supports are presented. It was found that tight tolerances must be employed at the end of the fuel rod experiencing the largest temperature asymmetry (i.e., the coolant outlet end). This precaution greatly reduces the magnitude of the initial bow of the rod and precludes the possibility of a channel thermal instability occurring. 3 references. (auth)

28639 THE APPLICATION OF THE ELECTRON MICROPROBE IN THE ANALYSIS OF NUCLEAR FUEL MELTDOWN EXPERIMENTS. Stachura, S. J.; Cooper, L. (Atomics International, Canoga Park, Calif.). Contract AT-(11-1)-GEN-8. Advan. X-Ray Anal., 10: 422-30(1967).

From 15th Annual Conference on Applications of X-Ray Analysis, Denver, Colo. See CONF-660814.

Transient (nuclear) heating experiments were conducted with UC fuel rods to study the failure characteristics of typical rod designs. Extremely unusual changes in microstructure were observed and the electron microprobe was employed to establish the disposition of materials resulting from the meltdown experiments. The probe results indicated substantial fuel-clad interactions and permitted the resolution of several uncertainties regarding the course of fuel rod failure and material redistribution. The electron microprobe represents a unique capability in the post-test analysis of such meltdown tests. 7 references. (auth)

28640 THERMAL INSULATION WITH METAL GAUZE AND FOIL FOR PRESTRESSED CONCRETE CONTAINMENT VESSELS. Arathoon, J. (Societe pour l'Industrie Atomique, Paris); Breuille, M.; Lecourt, Y. pp EN.1/2.1-10 of Symposium on the Technology of Integrated Primary Circuits for Power Reactors, Proceedings, Paris, 20th–22nd May 1968. Paris, European Nuclear Energy Agency, 1968. (In French).
See CONF-680525.

Operating conditions inside a prestressed concrete pressure vessel are described; types and requirements of thermal insulation for these vessels are outlined. The insulation used in the French (EDF) Reactors is described in detail; characteristic parameters are given. Mockup studies on the thermal behavior of the insulation are summarized; results are discussed. Fabrication and assembly of the metal gauze insulation are described. (M.L.S.)

28641 REAKTORDRUCKGEFAESS-STAEHLE UND IHR VERHALTEN UNTER BESTRAHLUNG. Vortraege Gehalten auf Einer Arbeitssitzung des Fachausschusses II, Strahlenwirkung auf Materie, am 30.3.1967. (Reactor Pressure Vessel Steels and Their Behavior Under Irradiation. Delivered at a Work Meeting of the Technical Round II, Radiation Effects on Materials, March 30, 1967. Fischer, E.; Melkonian, G. A. (eds.). Berichte der Studiengesellschaft zur Foerderung der Kernenergieverwertung in Schiffbau und Schiffahrt e.V., Hamburg (KERNENERGIE-Studiengesellschaft, KEST), Nr. 13. Muenchen, Verlag Karl Thiemig KG, 1968. 55p. (CONF-670336).

A separate abstract was prepared for each of the 4 papers presented. (J.S.R.)

For abstracts of individual papers see: 28467, 28567, 28597, and 28598.

28642 NUCLEAR REACTOR FUEL ASSEMBLY RUPTURE DETECTING SYSTEM. Gelius, H. (to Allmanna Svenska Elektriska Aktiebolaget). Canadian Patent 803,098. Dec. 31, 1968. Priority date Dec. 16, 1964, Sweden.

To detect breaks in the fuel cladding which introduces radioactive materials into the coolant system, a sampling device is incorporated into the fuelling machine. Any fuel channel may be sampled and the contents conveyed to a monitor outside the reactor. Only a single conduit is required and thus the number of openings from the interior of the reactor to the exterior is reduced. Details of plugs required to prevent escape of radioactivity and other devices are described. (F.S.A.)

28643 NUCLEAR REACTOR WITH TWO-DIMENSIONAL REACTIVITY CONTROL. Kobayashi, Iwao (to Japan Atomic Energy Research Inst.). Japanese Patent 1969-2676. Feb. 4, 1969. Filed Dec. 23, 1966.

The nuclear reactor proposed employs a two-dimensional reactor control, as against the three-dimensional one resulting from the use of vertical control rods. The advantages are the following: the compact reactor-core structure; elimination of the fluctuation in the center-of-gravity in ordinary vertical control rods, making it suitable for ship-propulsion reactors; and, flattening in the axial distribution of power output. A cylinder is inserted into another cylinder of larger diameter; the inner cylinder forms a regulating rod, while the outer one is a shim-control rod. Each cylinder is divided in half axially, and one half is made up of a neutron-absorbing material and the other half is of a non-absorbing material. Both the inner and the outer cylinder can be rotated separately by an external means. A plurality of the combinations of inner and outer cylinders are set halfway into the boundary region of the reactor core, along the axis of the reactor core, through the corresponding semi-circular cut in the core. By rotating the cylindrical control rods appropriately, the desired reactor control is achieved. (NSA of Japan)

28644 LIQUID-POISON DEVICE. Shirakawa, Toshimi (to Hitachi Ltd.). Japanese Patent 1969-75. Jan. 6, 1969. Filed Mar. 22, 1966.

By the method proposed, liquid poison can be injected into the reactor pressure vessel both rapidly and accurately. The conventional purifying system and the usual injection using a fall head are retained. The reactor has a purifying system, consisting of a purifier, filter, non-regenerative heat exchanger and regenerative heat exchanger. The purifier and regenerative heat exchanger and the filter and non-regenerative heat exchanger are connected, respectively, through valves. A jet pump is installed at the entrance of the reactor to a pipe connecting to the regenerative heat exchanger. Liquid poison is run into the reactor so as not to enter the purifying system by engaging with valves in the purifying system. (NSA of Japan)

GENERAL

28645 (AERE-R–5947) A FORTRAN SUBROUTINE FOR SOLVING SYSTEMS OF NONLINEAR ALGEBRAIC EQUATIONS. Powell, M. J. D. (Atomic Energy Research Establishment, Harwell (England)). Nov. 1968. 54p. Dep. CFSTI. UK 8s. 0d.

A Fortran subroutine is described and listed for solving a system of non-linear algebraic equations $f_k(x_1,x_2, \ldots, x_n) = 0$, $k = 1,2, \ldots, n$. The functions f_k should have continuous first derivatives, but there is no need to calculate these, because the algorithm automatically derives derivative approximations. The method used to obtain the solution to the equations is a compromise between the Newton–Raphson algorithm and the method of steepest descents applied to minimize the function $F(x_1,x_2, \ldots,x_n) = \Sigma_{k=1}^{n} [f_k(x_1,x_2, \ldots, x_n)]^2$, for the aim is to combine a fast rate of convergence with steady progress. Some examples illustrate the technique, and they indicate that the given algorithm compares favorably with other numerical methods for solving non-linear equations. (auth) (UK)

28646 (AERE-R–6009) DETERMINATION OF SULPHUR IN NICKEL. Parker, A.; Wallace, C. G.; Webber, T. J. (Atomic Energy Research Establishment, Harwell (England)). Mar. 1969. 13p. Dep. CFSTI. UK 2s. 6d.

A method is described for determination of microgram quantities of sulphur in nickel. The metal is dissolved in nitric acid containing bromine, the nitrate ions are removed, and a chloride solution of the nickel is treated with a titanous phosphate/phosphoric acid mixture in a stream of nitrogen. The evolved hydrogen sulphide is collected, reacted with p-phenylenediamine in the presence of ferric chloride, and the absorbency of the resultant Lauth's violet is measured. The coefficient of variation at the 130 ppM level using a 0.25-g sample is 8% and the limit of detection is 2 μg of sulphur. Up to 1 g of metal can be used per determination. (auth) (UK)

28647 (AERE-R–6072) A FORTRAN SUBROUTINE TO INVERT A RECTANGULAR MATRIX OF FULL RANK. Powell, M. J. D. (Atomic Energy Research Establishment, Harwell (England)). Apr. 1969. 13p. Dep. CFSTI. UK 2s. 6d.

A Fortran subroutine is presented that calculates the generalized inverse of an $m \times n$ $(n \geq m)$ matrix A, having rank m. A special feature of the method used is the economy of computer storage. The matrix A is over-written by the required generalized inverse and, apart from the program itself and some constants, only $(2m + n)$ additional storage locations are required. (auth) (UK)

28648 (AERE-R–6075) COMPUTER SCIENCE RESEARCH, 1968. Pyle, I. C.; Garside, R. G.; McLatchie, R. C. F.; Phillips, T. D.; Rimmer, D. E.; Taylor, J. R.; Vincent, D. G. (Atomic Energy Research Establishment, Harwell (England)). Apr. 1969. 26p. Dep. CFSTI. UK 4s. 0d.

A survey is presented in an attempt to present the "state of the art" in computer science research at the latter half of 1968. It draws largely on material presented at the IFIP Congress, 1968, but is not limited to that material. Hardware is not covered, nor all applications. Headings are as follows: Computer systems; operating systems; compiler techniques; data structures; file management; graphic displays; user interface; languages; facilities; automatic documentation; selected applications; picture processing; information retrieval; computer assisted training; and simulation. (UK)

28649 (ANL-7521) APPLIED MATHEMATICS DIVISION SUMMARY REPORT, JULY 1, 1967–JUNE 30, 1968. (Argonne National Lab., Ill.). Contract W-31-109-Eng-38. 96p. Dep. CFSTI.

Developments in computer systems and languages, numerical and mathematical research, computer utilization in divisional research, computer engineering, applied programming, digital computer operations, and the Argonne code center are reported. Also, publications and papers and seminars and symposia are listed. (W.H.K.)

28650 (AWRE-O-7/69) CHARGING CHOKE DESIGN FOR THE HICUP MODULATOR. Ward, G. M. (Atomic Weapons Research Establishment, Aldermaston (England)). Feb. 1969. 37p. Dep. CFSTI. UK 5s. 6d.

A machine known as HICUP (Hydraulic Impulse Crushing Unit Project) was designed for efficiently charging and discharging load capacitors. The machine was employed for electrohydraulic crushing of brittle materials and was capable of 4kW of spark power. The design of the charging choke incorporated into the machine is described. The interactions of such parameters as rms current, peak ampere turns, pulse repetition frequency and size are considered. The development of a graphical method for general application is presented. (auth) (UK)

28651 (BNWL-SA–1565) DYNAMIC ELECTRON MICROSCOPY OF HIGH-TEMPERATURE REACTIONS. Mayhan, S. J.; Daniel, J. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). July 31, 1968. Contract AT(45-1)-1830. 41p. (CONF-681126–1). Dep. CFSTI.

From 14th National Symposium of the Society of Aerospace Material and Process Engineers, Cocoa Beach, Fla.

Electron microscopy facilities for high temperature materials studies are described. A furnace for in-microscope heating, a gas chamber for studying chemical reactions, and equipment for studying radioactive samples are briefly described. Transmission, reflection, and scanning electron microscopy techniques are considered, and cinema photography methods are discussed. Some time series electronmicrographs of high-temperature structural and nuclear fuel materials are presented. (W.H.K.)

28652 (CALT–532-35) VACUUM ULTRAVIOLET PHOTOCHEMISTRY OF PROPANE ABOVE AND BELOW IONIZATION. Lane, Arthur Lonne (Illinois Univ., Urbana). Sept. 5, 1968. 341p. Dep. CFSTI.

Thesis.

The vacuum ultraviolet photochemistry of propane was studied above and below its first ionization potential (10.95 eV) with monochromatic light sources. Pure propane and neon–propane mixtures were photolyzed at several different pressures with light of 1236 Å (10.03 eV) and 1048 to 1067 Å (11.62-11.83 eV) over a decomposition range of 0.02 to 1%. Product analyses were performed by flame ionization gas chromatography and mass spectrometry. Product distributions were obtained with estimated errors of ±3% at 1236 Å and ±8% at 1048 to 1067 Å. The absorption coefficients and ionization efficiencies of propane were measured at the wavelengths of interest. The absorption coefficients are $\alpha(1067\ \text{Å}) = 1410\ \text{atm}^{-1}\ \text{cm}^{-1}$, and $\alpha(1048\ \text{Å}) = 1430\ \text{atm}^{-1}\ \text{cm}^{-1}$. The ionization efficiencies are I.E.(1067 Å) = 20% and I.E.(1048 Å) = 30%. The accuracy of these measurements is ±10%. The observed results show that any translationally hot H atoms which may be formed in the primary or secondary dissociations (such as $C_3H_8^{*} \rightarrow H + C_3H_7^{*}$ or $C_3H_7^{*} \rightarrow H + C_3H_6$) are thermalized before they react. Their reactions are the formation of H_2 via H atom abstractions from propane and addition to olefinic species. There is an effective competition between these two processes which depends upon the varying local concentration of olefin and propane. The collisional stabilization of the $C_3H_8^{+}$ ion appears to occur at pressures greater than 1 torr of propane; 0.4 torr of propane increases the mean collision interval to greater than 1×10^{-7} sec. At energies above ionization the presence of increased yields of C_5H_{12}, i-C_4H_{10}, n-C_4H_{10}, and H_2 per propane molecule photolyzed indicates an increased relative importance of radical formation over molecular detachment processes. These processes originate from the superexcited molecules which absorb 11.6 to 11.8 eV photons but do not ionize. Energy and pressure dependencies were found for the formation of acetylene from ethylene and propylene, and allene from propylene. (auth)

28653 (COO–1469-111) QUARTERLY TECHNICAL PROGRESS REPORT, JULY–SEPTEMBER 1968. (Illinois Univ., Urbana. Dept. of Computer Science). Contracts AT(11-1)-1469; AT(11-1)-1018. 199p. (COO–1018-1164). Dep. CFSTI.

Developments in the circuit research program, hardware and software systems research, Illinois pattern recognition computer: ILLIAC III, and ILLIAC IV are reported. Also, switching theory and logical design developments, report of the statistical consultants, IBM system/360 service, IBM 7094/1401 service, use, and development, and general department information are outlined. (W.H.K)

28654 (DP–1186) ACID CONCENTRATION MONITOR. Tilley, Hilton R. Sr. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Mar. 1969. Contract AT(07-2)-1. 14p. Dep. CFSTI.

An instrument for automatically measuring nitric acid concentrations over the range 0.1 to 2.75 normal is described. Acid concentration is determined by measuring conductivity with an electrodeless conductivity cell. The instrument is reliable, capable of continuous remote operation, and accurate within ±5% of reading above 0.5 normal. Temperature compensation is accomplished electronically with a thermistor. (auth)

28655 (DUN-SA–59) WARM WATER IRRIGATION PROPOSAL. Woods, W. K. ([Douglas United Nuclear, Inc., Richland, Wash.]). Feb. 9, 1968. 8p. Dep. CFSTI.

Since the effects of warm water irrigation on plant growth and soils are largely unknown, a large scale experiment is proposed for comparing the results of cold water irrigation with those using warm water produced in the condenser of a nuclear power plant. The proposal has been submitted to the AEC and awaits approval and funding. (L.C.L.)

28656 (IS-T-297) ALGORITHM FOR EIGENVECTORS OF NON-HERMITIAN MATRICES. Erisman, Albert Maurice (Ames Lab., Iowa). Feb. 1969. Contract W-7405-eng-82. 78p. Dep. CFSTI.

Thesis.

A numerical method for determining eigenvectors of nonhermitian matrices is developed. The method is based on the theorem: For an $n \times n$ complex matrix A and non-zero vectors x and y^*, then $Axy^*-xy^*A = 0$ if and only if x and y^* are column and row eigenvectors of A respectively corresponding to the same eigenvalue. The algorithm is illustrated for real matrices with real eigenvalues for three cases: a well conditioned matrix with well separated roots, a well conditioned matrix with close roots, and a poorly conditioned matrix. In each case, the corresponding calculated eigenvalues are compared with those calculated by the QR algorithm, the best known method for calculating eigenvalues of non-hermitian matrices. An example using a complete matrix is also included. The method developed has the advantage that all work is done with the original matrix; thus there is no accumulation of round-off error either in determining the sequence of approximations or in determining approximations to eigenvectors corresponding to sub-dominant roots. Present limitations of the method as well as suggestions for its improvement and refinement are given. (W.H.K.)

28657 (K-DP-3109(Rev.1)) GENOUT: A GENERALIZED OUTPUT PROGRAM FOR NUCLEAR SCIENCE REFERENCE DATA. Owings, Jack H. (Union Carbide Corp., Oak Ridge, Tenn. Computing Technology Center). Apr. 9, 1969. Contract W-7405-eng-26. 49p. Dep. CFSTI.

GENOUT is a 7090 Computer Program which operates on the data base represented by the cataloging and indexing of Nuclear Science Abstracts. This program provides capability to select entries from these data which meet specified bibliographic criteria and output them in a variety of formats. Citations, Subject Headings and Modifiers, and keywords can be listed (or not, as desired) to comprise a "miniabstract." These can be sorted, after selection, on various fields as desired and listed with sequence numbers assigned. Then, the usual NSA indexes can be prepared to these sequence numbers, if desired. (auth)

28658 (MLM-1631) STABLE ISOTOPE SALES: MOUND LABORATORY CUSTOMERS AND SHIPMENT SUMMARIES, FY-1968. Cox, J. G. (comp.) (Mound Lab., Miamisburg, Ohio). May 1, 1969. Contract AT-33-1-GEN-53. 21p. Dep. CFSTI.

A listing of Mound Laboratory's stable isotope sales for fiscal year 1968 is given. Purchasers are listed alphabetically and are divided into domestic and foreign groups. A cross-referenced index, by state of purchase, is included for domestic customers and cross-referenced listings, by isotope purchased, are included for all customers. (auth)

28659 (ORNL-TM-2544) BIOLOGY DIVISION QUARTERLY PROGRESS REPORT TO THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, JANUARY 1-MARCH 31, 1968. Smith, Diana B.; de Serres, F. J. (Oak Ridge National Lab., Tenn.). May 1969. 208p. Dep. CFSTI.

A series of computer programs were written to facilitate the statistical analysis of large-scale forward-mutation experiments on the haploid organism *Neurospora crassa*. Specifically, the experiments involved induction of recessive lethal mutations at specific loci using a genetically balanced 2-component heterokaryon. Adenine-3 (ad-3) mutants were detected by the appearance of purple pigment as opposed to white in the nonmutant colonies. Each ad-3 mutant was tested extensively to characterize it as to whether the mutation in the ad-3 region was a point mutation, a chromosome deletion, or a point mutation with a separate site of recessive lethal damage elsewhere in the genome. In addition, since the ad-3B locus codes for a polymer, mutants at this locus showed allelic complementation and could be characterized according to their complementation patterns as nonpolarized, polarized, or noncomplementing. Different mutagenic agents had different frequencies of mutation-induction for each of the different classes according to their mode of action. (auth)

28660 (ORNL-TM-2569) COMPUTER ANALYSIS OF THREE-FACTOR INTERACTIONS IN CONTINGENCY TABLES. Kastenbaum, Marvin A. (Oak Ridge National Lab., Tenn.). May 1969. Contract W-7405-eng-26. 53p. Dep. CFSTI.

Numerous methods have been proposed for testing the hypothesis of zero three-factor interaction in contingency tables. These methods are incorporated into a single computer program which is designed to calculate the test statistics by any or all of the proposed techniques, and which also provides estimators of the interactions and corresponding two-sided confidence intervals. The program was written in ASA FORTRAN for the CDC-3600 and CDC 1604 computers, and will analyze interactions in contingency tables of dimensions $2 \leq r \leq 5$, $2 \leq s \leq 5$, $2 \leq t \leq 16$, for $r \leq s \leq t$. (auth)

28661 (RISO-M-842) THE THEORY AND DESIGN OF A DUAL SYNCHRONOUS NULL INDICATOR FOR A FIXED AUDIO FREQUENCY. Diamond, Joseph M. (Danish Atomic Energy Commission, Risoe. Research Establishment). Jan. 1969. 24p. Dep.

A fixed frequency phase sensitive detector is described which displays both in-phase and quadrature components of the signal voltage. The instrument has been designed for bridge balancing at 1005 Hz, and includes an oscillator, phase splitter, phase shifters, detector circuits, squaring circuits and metering circuits. The design of these circuits is discussed, and in addition the general problems involved in the design of a sensitive phase sensitive detector are considered. These include the equivalance of the multiplier and gating types of detector, the equivalence of pre- and post-detection filtering as regards both signal and noise, the degree of pre-filtering needed to avoid noise saturation, the equivalence of half and full wave detection and the cancellation of offsets in full wave chopper circuits. (auth)

28662 (SC-RR-68-592) IMPROVED MODEL OF THE VACUUM PROBE. Morris, M. E.; Hughes, L. W.; Parisi, A.; Beakley, J. W.; Whitfield, W. J.; Sivinski, H. D. (Sandia Labs., Albuquerque, N. Mex.). Sept. 1968. Contract NASA R-09-019-040. 34p. Dep. CFSTI.

The need for a microbiological surface sampling device with the capability for sampling large areas that are lightly loaded with microorganisms motivated the development of the vacuum probe. The intended use of the instrument is to sample clean surfaces in laminar flow clean rooms, but the device could be utilized for sampling surfaces in other clean environments. Such a device was designed, fabricated, and tested at Sandia Laboratories, Albuquerque, New Mexico. In these tests the vacuum probe removed a mean of 89% and assayed a mean of 67% of bacterial spores approximately $1\ \mu$ in length settled on smooth surfaces which were free of viscous films. Detailed machine and assembly drawings and instructions are included. (auth)

28663 (SCL-RR-68-26) ANALYSIS OF SHALLOW SPHERICAL CANTILEVERED SHELLS AND SHALLOW SPHERICAL DOMES WITH POLAR OPENINGS UNDER SYMMETRICALLY DISTRIBUTED LOADS. Fettahlioglu, Omer A. (Sandia Labs., Livermore, Calif.). Mar. 1969. Contract AT(29-1)-789. 186p. Dep. CFSTI.

A mathematical analysis of the stresses and deflections in thin shallow spherical shells subjected to rotationally symmetrical distributed loads is presented. The shells are considered to be of constant thickness and isotropic construction and to be supported continuously either near the apex or along the outer boundary by a rigid ring. A simplified yet accurate analysis is accomplished by the application of bending shell theory. The equations are specialized to provide solutions for either fixed or simply supported structures. Results are presented in the form of nondimensional curves which provide stresses and deflections in the most general form. (auth)

28664 (SLAC-102) CIL: COMPILER IMPLEMENTATION LANGUAGE. Gries, David (Stanford Linear Accelerator Center, Calif.). Mar. 1969. Contract AT(04-3)-515. 119p. Dep. CFSTI.

The Compiler Implementation Language, designed for writing compilers for the IBM 360 computers, is described. The heart of the system is a procedure oriented ALGOL-like language with expressions, assignment statements, iterative statements, etc. However the basic data types of the language are those of the IBM 360—byte, halfword integer, sequence of 1 to 256 bytes, etc—while the basic operations on these types of data are also those of the 360. This should allow the compiler writer to have more feeling for the code generated by the metacompiler and thus make it possible to write more efficient compilers. (W.H.K.)

28665 (SLAC-PUB-538) FORMAL DESCRIPTION FOR TWO-DIMENSIONAL PATTERNS. Zahn, C. T. (Stanford Linear Accelerator Center, Calif.). Mar. 1969. 8p. (CONF-690511-1). Dep. CFSTI.

From International Joint Conference on Artificial Intelligence, Washington, D. C.

A "structural description" for two-dimensional black and white patterns is defined as the set of contour lines for an appropriate function which fits the binary pattern. These contour lines are mutually non-intersecting closed polygonal curves with edges in only eight different directions and they represent the boundaries between connected black and white areas of the pattern. Rigorous procedures are described to transform a "matrix pattern" into a "structural description" and vice versa. Advantages of this method for describing patterns previous to pattern recognition are discussed at some length. (auth)

28666 (SLAC-PUB-573) HARDWARE AND SOFTWARE FOR EFFECTIVE MAN-MACHINE INTERACTION IN THE LABORATORY. Miller, W. F. (Stanford Univ., Calif.). Mar. 1969. 18p. (CONF-690301-4). Dep. CFSTI.

From Conference on Computer Systems in Experimental Nuclear Physics, Skytop, Pa.

The development of computer meta-systems and research on models of control at Stanford University are outlined. The meta-system GLAF for graphics and pattern recognition is briefly described. (W.H.K.)

28667 (UCRL-50624) EVALUATION OF EXPANSION CHAMBERS IN SHOCK TUBES. Richter, Horst P. (California Univ., Livermore. Lawrence Radiation Lab.). Mar. 25, 1969. 7p. Dep. CFSTI.

Equations for calculating flow losses in a supersonic flow are discussed and are applied to shock tube measurements. The calculations show that the flow losses are only a few percent of the kinetic energy of the gas flow when an expansion chamber is used. The flow regime of the measurements considers velocities of a few centimeters per microsecond. The stagnation pressure and temperature remain high and affect the design of efficient valves which stop the flow. Equations that may become useful in determining parameters in an equation of state for the unknown gas flow through such a tube are also given. The discussion shows that adequate measurements of pressures and flow velocities are essential for realistic calculations. (auth)

28668 (UCRL-71574) MAGNETIC PULSER FOR PAM MULTIPLEXED INSTRUMENTATION POWERED AND TIMED FROM 10 kHz 3 PHASE AC. Aaland, Kris; Pence, Glynn A. (California Univ., Livermore. Lawrence Radiation Lab.). Apr. 1969. 27p. Dep. CFSTI.

An all magnetic pulser for multiplexing 80 transducers was developed. Three groups power 240 transducers with a 0.3-μs wide pulse in a repetitive pattern every 50 μs, hence has a combined group rate of 4.8×10^6 amplitude modulated pulses per second. Power and timing are provided by a 10-kHz, 3-phase ac line. The pulse forming network, connected between part of the magnetic pulser and transducer it drives, is effected by a modified Melville line which incorporates a 30-meter long transmission line. The magnetic pulser provides reliable operation in a hazardous (radiation) environment and replaces an earlier unit which required thousands of transistors. The magnetic pulser is a further step in the evolution of design using saturable reactors. (auth)

28669 (UCRL-71678) OVERVIEW OF COMPUTER-AIDED CIRCUIT DESIGN. Kuo, Franklin F.; Magnuson, Waldo G. Jr. (California Univ., Livermore. Lawrence Radiation Lab.). Apr. 30, 1969. 7p. (CONF-690410-1). Dep. CFSTI.

From Symposium on Information Processing, Lafayette, Ind.

A review of the development of computer-aided circuit design, mainly integrated circuits, is presented. Progress toward achieving large-scale integration whereby hundreds of gates can be fabricated on a single chip is summarized. Also, the use of graphic consoles for computer input and output is discussed. (W.H.K.)

28670 (WANL-TME-1888) FEATS: A COMPUTER PROGRAM FOR THE FINITE ELEMENT THERMAL STRESS ANALYSIS OF PLANE OR AXISYMMETRIC SOLIDS. Swanson, J. A. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Dec. 1968. 142p. Dep. CFSTI.

A new coupled two-dimensional temperature stress code developed at Westinghouse Astronuclear Laboratory in support of the NERVA (Nuclear Engine for Rocket Vehicle Application) Program (Contract NP-1) called FEATS (Finite Element Analysis-Temperature and Stress) is described. This code calculates, by finite element analysis, the temperature and stress fields for either axisymmetric or plane two-dimensional bodies with a variety of boundary conditions including prescribed displacements, loads, and temperature boundary conditions. A description of the required input data cards is presented along with several examples illustrating the operation of the program. FEATS is written in FORTRAN IV for the CDC 6600 or IBM 360/75 computers. There are two sizes of the FEATS code, one requiring 105000_8 storage location and the larger requiring 225000_8. (auth)

28671 INFORMATIONEN ZUR KERNFORSCHUNG UND KERNTECHNIK, Nr. 1, 1969. (Information Concerning Nuclear Research and Engineering, No. 1, 1969). Frankfurt am Main, Zentralstelle fuer Atomkernenergie-Dokumentation, 1969. 74p. DM 60,-.

Over 300 references, with phase expressions giving the main points treated, are presented under the following topics: general, biology and medicine, chemistry, earth and space sciences, engineering, radiation protection, instrumentation, materials, physics, and reactor physics and technology. Conference, author, report number, and subject indexes are included. (M.C.G.)

28672 INFORMATIONEN ZUR KERNFORSCHUNG UND KERNTECHNIK, Nr. 2, 1969. (Information Concerning Nuclear Research and Engineering, No. 2, 1969). Frankfurt am Main, Zentralstelle fuer Atomkernenergie-Dokumentation, 1969. 80p. DM 60,-.

Almost 400 references, with phase expressions giving the main points treated, are presented under the following topics: general, biology and medicine, chemistry, earth and space sciences, engineering, radiation protection, instrumentation, materials, physics, and reactor physics and technology. Conference, author, report number, and subject indexes are included. (M.C.G.)